Aviation Week & Space Technology

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A McGraw-Hill Publication

April 1, 1963

U. S. Supersonic Transport Drive Accelerated

NASA SCAT 15's Six Variable Wing Positions

The Honeywell Visicorder oscillograph & GUNPOWDER records forces in circuit breaker bushings

Wham! Forces imposed by the operation of oil-filled circuit breakers—especially during short-circuit interruption—are destructive enough to damage bushings. Engineers at the Ohio Brass Company have devised an ingenious method of simulating this explosive force in order to analyze bushing loads.

On a typical bushing, they mounted a dummy interrupter, in which they exploded gunpowder to propel from the interrupter fist-sized metal projectiles.

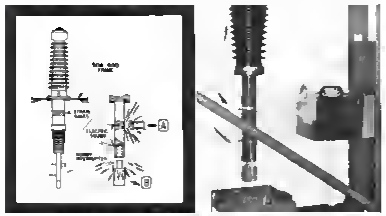
Strain gages, installed on the bushing ground sleeve, were connected to a Honeywell 119 Amplifier.

A Honeywell 906 Visicorder oscillograph was chosen to record the test data because of the extremely high speed and transient nature of the signals to be measured.

A typical record of this test, shown at right, was made at a record speed of 50" second.

These Ohio Brass tests have opened the way to the development of standards for the mechanical performance of bushings (AIEE papers 62-153, 60-107).

This application is only one of thousands where the Visicorder is called upon daily as a basic research, test, and development tool. One of the six different Visicorder models should be a basic instrument in the management of your data acquisition.

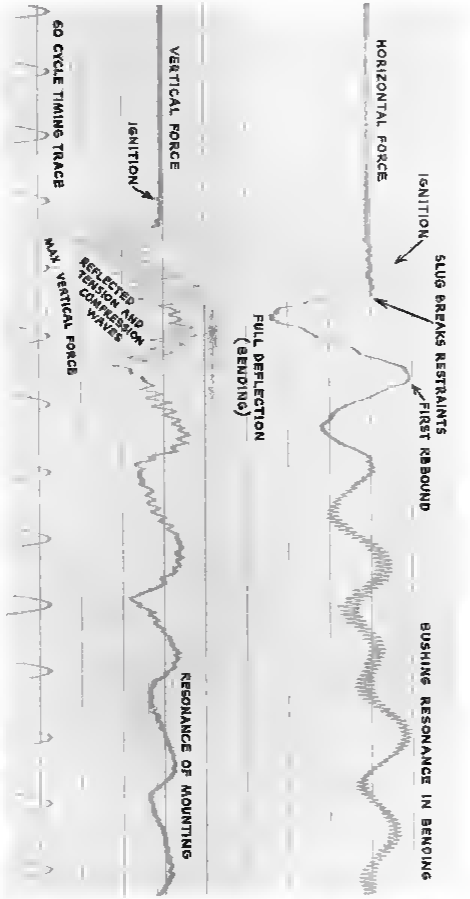


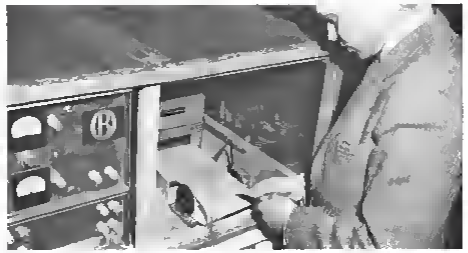
Schematic at left diagrams method for duplicating bushing loads during short circuit interruptions. Projectile (A) produces lateral losses at right angles to bushing axis; projectile (B) produces axial load on bushing terminal. At right, squibs have just detonated charges propelling projectiles from dummy interrupter. Below, Honeywell Model 906 Visicorder Oscillograph records circuit breaker bushing test for Ohio Brass.

For full details on all Visicorder Oscillographs, tape systems and signal conditioning equipment, write to Honeywell, Heiland Division, Denver 10, Colo. or phone 303 794 4311

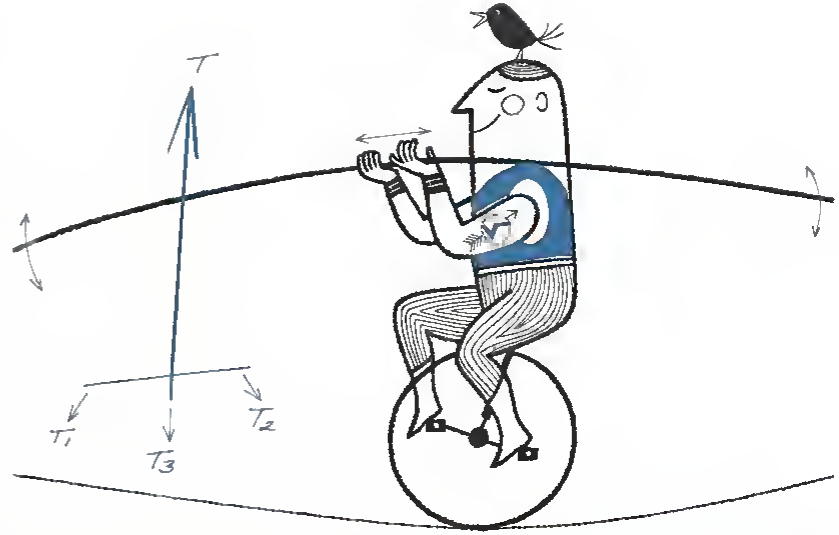
DATA HANDLING SYSTEMS

Honeywell





The Honeywell Model 906 Visicorder Oscillograph—with a Honeywell Model 119 Amplifier—record circuit bushing tests for Ohio Brass.



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1802

AEROSPACE CALENDAR

Apr 8-11—National Aero-Nautical Meeting, Production Forum & Aerospace Support Equipment Conference, SAE/American Society of Naval Engineers, Sheraton Park Hotel, Washington, D C

Apr 10—1963 National Value Engineering Conference. For information: Dr David Miller, coordinator of special programs, Los Angeles State College, 5151 State College Dr, Los Angeles 32, Calif

Apr 10-11—Fourth Symposium on Engineering Aspects of Magnetohydrodynamics, University of California, Berkeley

Apr 10-11—Photovoltaic Specialists Meeting, Institute of Electrical and Electronics Engineers, Statler Hilton Hotel, Washington, D C

Apr 16—Institute of Navigation's Western Region Meeting, Charter House Hotel, Anaheim, Calif

Apr 16-17—Ohio Valley Instrument Automation Electronic Exhibition & Symposium, Cincinnati Gardens and Carrousel Inn, Cincinnati, Ohio

Apr 16-18—National Meeting, Aerospace Industries Assn's Export Committee, Cramercy Inn, Washington, D C

Apr 16-18—Optical Masers Symposium, Waldorf Astoria, New York N Y. Sponsors: Polytechnic Institute of Brooklyn, IEEE, American Optical Society, Armed Services

Apr 16-19—1963 USAF Aerospace Fluids and Lubricants Conference (unclassified), San Antonio, Tex. Managed by Southwest Research Institute

Apr 17-19—Annual Technical Meeting and

(Continued on page 7)

AVIATION WEEK & Space Technology

April 1, 1963

Vol 78, No 13

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AEROSPACE CALENDAR

(Continued from page 5)

Equipment Exposition, Institute of Environmental Sciences, Statler Hilton Hotel, Los Angeles, Calif.

Apr. 17-19—International Nonlinear Magnetics (INTERMAG) Conference. Institute of Electrical and Electronics Engineers, Shoreham Hotel, Washington.

Apr. 17-19—Southwestern Conference and Electronic Show. Institute of Electrical and Electronics Engineers, Dallas Memorial Auditorium, Dallas, Tex.

Apr. 17-19—Technical Meeting. Nuclear Materials for Space Applications, American Nuclear Society, Netherland Hilton Hotel, Cincinnati, Ohio.

Apr. 22-23—Annual Meeting, National Aeronautical Services Assn., Washington, D.C.

Apr. 22-24—Second Manned Space Flight Symposium, AIAA/NASA, Marriott Hotel, Dallas, Tex.

Apr. 22-24—Third Annual San Diego Symposium for Biomedical Engineering, Del Webb's Oceanhouse, San Diego, Calif.

Apr. 22-25—10th Weather Radar Conference, American Meteorological Society, International Inn, Washington, D.C.

Apr. 23-25—Hypersonic Ramjets Conference, AIAA/ASME, Naval Ordnance Laboratory, White Oak, Md. (Secret)

Apr. 23-25—National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla.

Apr. 25-26—Annual Convention, Society of American Valve Engineers, Americana Hotel, New York, N.Y.

Apr. 29-30—1963 Spring Meeting, Western States Section/The Combustion Institute, Vacation Village Motel, San Diego, Calif. Sponsor, General Dynamics/Astronautics.

Apr. 29-May 2—34th Annual Scientific Meeting, Aerospace Medical Assn., Statler Hilton Hotel, Los Angeles, Calif.

Apr. 29-May 2—22nd Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton Jefferson Hotel, St. Louis, Mo.

Apr. 29-May 2—Spring Meeting, United States National Committee of International Scientific Radio Union (URSI), National Academy of Sciences-National Research Council, Washington, D.C.

Apr. 29-May 3—Annual Conference, Society of Photographic Scientists and Engineers, Ambassador Hotel, Atlantic City, N.J. Co-sponsor, Army Research Office.

May 1-3—19th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D.C.

May 1-9—Third National Conference on the Peaceful Uses of Space, Chicago, Ill. Sponsors: NASA, Committee for Economic and Cultural Development of Chicago.

May 2—Manned Space Laboratory Conference, AIAA/Aerospace Medical Assn., Statler-Hilton Hotel, Los Angeles, Calif.

May 2-3—Fourth National Symposium on Human Factors in Electronics, IEEE, Marriott Twin Bridges Motel, Washington, D.C.

May 2-5—International Travel Fair and Flying Display, Biggin Hill Airport, Kent, England.

May 5-8—1963 Annual Conference, Amen

(Continued on page 9)

AEROSPACE CALENDAR

(Continued from page 7)

can Assn. of Airport Executives, Galt Ocean Mile, Beach Club and Coral Ridge Hotels, Fort Lauderdale, Fla.

May 6-8—Aerospace Reliability and Maintainability Meeting, AIAA/ASME/SAE, Washington, D.C.

May 6-9—Ninth Annual Aerospace Symposium, Instrument Society of America, Jack Tar Hotel, San Francisco, Calif.

May 7-9—Electronic Components Conference, Institute of Electrical and Electronics Engineers, International Inn, Washington, D.C.

May 8-9—60th Meeting, National Aerospace Standards Committee of the Aerospace Industries Assn., Hotel Roosevelt, New York, N.Y.

May 8-10—Spring Meeting, Society for Experimental Stress Analysis, Hotel Benjamin Franklin, Seattle, Wash.

May 9-10—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Fort Worth, Tex.

May 13-15—National Aerospace Electronics Conference, IEEE/AIAA, Dayton, Ohio.

May 15-16—Fourth Annual Symposium on High Speed Testing, Hotel Somerset, Boston, Mass. Sponsor: Plas-Tech Equipment Corp.

May 15-17—Connecticut General Flight Forum's Second National Symposium on Air Transportation, Hartford, Conn.

May 20-22—National Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Miramar Hotel, Santa Monica, Calif.

May 20-22—National Telemetering Conference, Hilton Hotel, Albuquerque, N.M.

May 21-23—Spring Joint Computer Conference, American Federation of Information Processing Societies, Cobo Hall, Detroit, Mich.

May 21-23—Symposium Characteristics of the Lunar Surface, Boston, Mass. Sponsors: Air Force Cambridge Research Laboratories, Arthur D. Little, Inc.

May 21-24—25th Annual Meeting and News Conference, Aviation/Space Writers Assn., Adolphus Hotel, Dallas, Tex.

May 27-28—Seventh National Conference on Product Engineering & Production, Institute of Electrical and Electronics Engineers, Continental Hotel, Cambridge, Mass.

June 3-11—COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland.

June 6-7—Symposium on the Exploration of Mars, Denver Hilton Hotel, Denver, Colo. Sponsor: American Astronautical Society. Co-sponsors: American Astronomical Society, American Institute of Biological Sciences, AIAA Rocky Mountain Sections, NASA.

June 7-8—14th National Maintenance & Operations Meeting, Reading Aviation Service, Reading, Pa.

June 7-16—25th French International Air Show, Le Bourget, Paris, France.

June 17-20—Summer Meeting, American Institute of Aeronautics and Astronautics (AIAA), Hotel Ambassador, Los Angeles.

June 28-July 3—Second Annual Dorado Fly In, Dorado Beach Hotel, Dorado, Puerto Rico.

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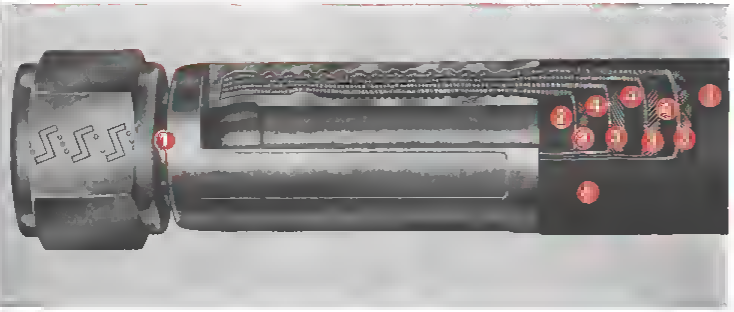

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DASH SIZE & OD TUBE SIZES AVAILABLE	-4, -6, -8, -10, 12	-4 -6, -8	-4, -6 -8
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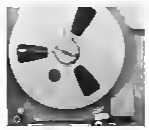

AMPEX

AAE REPORTS ON ADVANCED AERIAL RECOVERY TECHNIQUES

RECOVERY—MID AIR All American Engineering Company's aerial recovery gear for helicopters avoids costly damage to descending instrument packages and target drones. Recovery is reduced from hours (sometimes days) to minutes. When caught, the item is gently lowered to the ground, dry, undamaged and ready to be used again. An H-43B is shown with practice capsule in tow over Holloman Air Force Base, New Mexico.

MISSILE RECOVERY An Army H-37 helicopter poised for recovery over White Sands Missile Range, this system uses All American's new Model 80D recovery winch and is capable of "air catching" packages weighing 3,000 pounds.

THE "BIG" CATCH All American developed equipment scores again as the practice capsule is brought aboard an Air Force C-130 Military services now have units whose primary missions are aerial recovery.

BALLOON STATION PICK-UP An Air Force Air Rescue Service SA-16 engages a balloon during surface-to-air recovery. First used to recover a camera packet from the "Echo II," this technique has been used to lift packages ranging from 25 pounds to nearly one ton.

Developing and proving new aerial recovery techniques began at All American Engineering Company the day airmail pick-up and delivery started over 20 years ago.

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WHAT MAKES "INSTRUMENTATION CABLE" DIFFERENT?

It is no more like power or control cable than a Ferrari is like the old family sedan. Not knowing this can cause you a lot of grief: project delays, costly replacements, malfunctions.

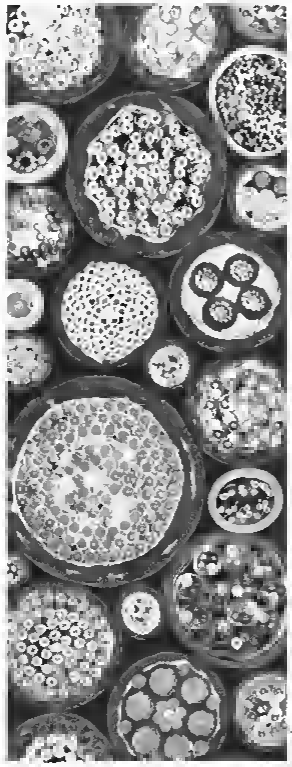
THE THIN BLACK LINE On your schematics instrumentation cable is a black line from launching pad to blockhouse or from one part of a computor to another. In the broadest sense it connects data or signal sources with display or recording or control devices. Its function is to carry those signals unfailingly and with the required reliability. In this day and age, it's no easy job.

WHAT CAN GO WRONG The improperly designed cable can simply fail. This has happened and at important sites. An untried saturant, lacquer or compound ingredient used in the cable may destroy the electrical integrity of this primary insulation. This sort of deterioration need not be sudden: only experts know which impregnants will migrate in a week or a month or more.

Or a relative lack of art in manufacture may create problems for the future. Under certain circumstances in use, variations in insulation thickness, conductor placement, or conductor unbalance in the cable lay-up may cause spurious or ambiguous signals to arrive at the display, recording or control panel. Your sharp, precise pulses become displaced in time, are a little too fuzzy, or are joined by other unwanted signals from another line.

DESIGN IS HALF THE STORY Configuration of conductors within the cable is important, for physical as well as for electrical reasons. For example, positioning of coaxial components within the cable is critical in order to assure maintenance of minimum standards of concentricity between the inner and outer conductors when the cables may be subjected to bending operations during installation work.

Selection of insulating, filler and jacketing materials requires expert knowledge and judgment. Some materials, as mentioned above, tend to migrate. Others harden or soften with cold or heat. Some change their electrical characteristics in time. These are not fundamentally new problems in cable design, *but in instrumentation cable the standards are far more severe than ever before.*



MANUFACTURE IS THE OTHER HALF Even a properly designed cable may well become unacceptable sooner or later if it is not manufactured to new standards of precision. This requires stranding machines that reduce circular eccentricity to remarkably low figures and help assure insulation uniformity, insulating machines of considerable precision and highly precise cabling equipment. It also requires, as is so often the case in precision manufacture, an indefinable skill on the part of machine operators.

ASK THE EXPERTS To protect the functioning of your system there's only one way to make sure the thin black lines on your schematics became cables with the requisite dependability: have them designed by experts, in consultation with you, and constructed by experts.

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We now have a 24-page booklet titled "Instrumentation Cables, Cable Assemblies and Hook-up Wires." In it, we describe instrumentation cable constructions, production, military specifications and our qualifications. For your copy, write Rome Cable Division of Alcoa, Dept. 26-43, Rome, N.Y.

ALCOA
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Volume 78
Number 13

Aviation Week & Space Technology

April 1, 1963

CONTENTS

COVER: National Aeronautics and Space Administration's SCAT 15 design has an arrow-shaped wing with variable sweep wing positions for low, medium and high speed flight. Wing is twisted and cambered to reduce drag due to lift (see story p. 58). Cover photo was taken using multiple exposure techniques. Small outboard tail surfaces improve stability.

PICTURE CREDITS
Cover—Robert Nye, NASA Langley Research Center; 32, 58, 59, 60, 61, 92—NASA; 34—Mitsubishi Aircraft; 57—Hawker Siddeley; 70—Aviation Week; 74, 78—Erwin J. Bulban; 94—Cessna; 95, 96—Beech

EDITORIAL

PT Boat Government

(The management or lack of it, of the nation's scientific, engineering and economic resources occupies the time and attention of many men in government. This problem is seen with different perspectives by those inside the aerospace industry—which relies so heavily on these national resources—and those outside it. AVIATION WEEK & SPACE TECHNOLOGY is publishing the view of one such outsider, James Reston, the distinguished Washington bureau chief of the New York Times. This column appeared in the Times' Western Edition on May 25.)

President Kennedy was a PT boat operator in the war, and in some ways his Administration resembles a PT boat operation.

There is a great deal of swift and dramatic rushing about. It does not give the impression of an organized fleet moving powerfully together on a predetermined course, but of a scurry of powerful little boats darting here and there with motors roaring full out.

Here is Vice President Johnson, for example, launching an attack on Congress for daring to question the Administration's budget for outer space, and calling on the scientific community to support his efforts (see p. 35).

Yet there is the Dept. of Commerce speeding off in precisely the opposite direction and asking whether too many scientific and engineering brains are not going into defense, space and the military atom rather than into the lagging civilian economy.

Economic War at Home

Similarly, the Atomic Energy Commission, which is also moving on Congress for another whopping budget, glories in the prospects of the peaceful atom, while David E. Lilienthal, the first chairman of the Atomic Energy Commission, is arguing at Princeton that the AEC operation is out of date, over-financed, and badly in need of pruning and re-organization.

The President now seems to be more concerned about the developing economic war at home and abroad than about the cold war, but two-thirds of the nation's trained minds are absorbed by the Pentagon, the space agency and the AEC.

He is worried about this and his principal scientific advisers are even more worried than he is, but the imbalance continues primarily because it is easier to get Congress to vote funds for military and related purposes than for civilian development or economic growth.

"We have," he said in his economic report to the Congress, "paid a price by sharply limiting the scarce scientific and engineering resources available to the civilian sectors of the American economy." But so far as can be determined, he is going along with Vice President Johnson's theme rather than with his other aides who want to concentrate more on developing old and finding new industries in order, as someone has said, "to get this country going again."

Last year, the U.S. government put almost $15 billion into research and development. This was more than the government spent on research and development from the beginning of the nation up to and through the second World War.

But while moderate observers of the economic scene, such as the chairman of the Federal Reserve Board, William McChesney Martin, are arguing that the development of new industries is the key to our economic problem, most of the research and development money continues to pour into space, atomic energy and defense.

The argument for this, of course, is that it is essential to the security of the country and also benefits the civilian economy, but even Defense Secretary McNamara is beginning to argue that the military budget is getting out of hand, that there is more "security" for the U.S. in the long run in arms limitation than in the arms race, and that the economy of the nation, which supports the military and everything else, is too serious a problem to be determined by soldiers who want more and more weapons and politicians who want more and more contracts for their districts.

Despite the argument that the research and development projects for space, defense and atomic energy help the civilian economy, the figures on economic growth do not support it. The average annual rate of economic growth declined from 3.7 in the period 1947-54 to 3.0 in the period 1954-60—this at a time when expenditures from research and development tripled.

As Dr. Herbert Hollomon, assistant secretary of commerce for science and technology, has pointed out, the translation of this new space, defense and atomic energy technology to the civilian economy "is neither direct, nor cheap, nor inevitable."

Meanwhile, West Germany, Japan, and our other leading competitors for the export markets of the world are putting most of their scientific and technical brains into projects of pure science or science applied directly, not to space or defense, but the development of industry and commerce.

Left to Caprice

The point of all this is not that the allocation of scientific engineering brains is necessarily wrong—it would take a panel of geniuses to decide—but that the issue is not being analyzed in detail. It is being left largely to the caprice of the several departments concerned and the Congress.

Naturally, the Joint Chiefs of Staff, the space chiefs and the AEC have a vested interest in getting everything they can from Congress, and Congress, being skeptical of their demands—not without some justification—wants to cut them back and reduce the deficit.

But the President has an obligation to choose between the competing demands of the cold and the economic war, and there is a growing feeling here that he is not choosing on what is best for the country's future but on what he is most likely to get through a military-minded Congress.

WHO'S WHERE

In the Front Office

Leonard C. Mallet, vice president of United Aircraft Corp. and president of Pratt & Whitney Aircraft Div., has been proposed as a director of The Stanley Works, New Britain, Conn., to succeed Maurice Stanley.

Richard M. Mock, former president of Lear, Inc., elected a director of Servomechanisms, Inc., El Segundo, Calif.

Charles W. Newhall, Jr., vice president, The Marquardt Corp., Van Nuys, Calif.

Thomas E. Stewart, executive vice president, Electro Mechanical Research, Inc., Sarasota, Fla., responsible for the operating divisions of the company, and **Donald M. Powers**, vice president responsible for corporate marketing and planning activities. Also **M. L. Van Doren**, division general manager of the Sarasota Div. (a combination of the former Systems and Sarasota Products Div.) and **William A. Ogletree**, assistant division general manager, **Earle W. Wallick**, general manager of Princeton Div.

The Dow Corning Corp., Midland, Mich., has elected the following as vice presidents: **R. William Caldwell**, director of engineering; **Howard N. Fenn**, director of manufacturing; Dr. **Melvin J. Hunter**, director of research. Also **Burl D. Huber**, elected treasurer.

H. M. Conner, assistant to the president of Fairchild Stratos Corp., and manager of the Washington, D.C., office.

Brig. Gen. Richard M. Hurst (USA, ret.), former commander of the Army Ballistic Missile Agency, vice president for planning, Textron's Bell Aerosystems, Buffalo.

Maurice W. Horrell, vice president-engineering and manufacturing, Univac Div., Sperry Rand Corp., New York, N.Y., and **Addison E. Wiles**, vice president-manufacturing services, Remington Rand Div., Sperry Rand Corp.

A. K. Wing, Jr., a vice president, ITT Electron Tube Div. of International Telephone and Telegraph Corp., New York, N.Y., responsible for technical operations and policies.

Thomas D. O'Keefe, in charge of aeronautics for the Dept. of Commerce until his resignation, appointed vice president of Charlotte Aircraft Corp., with offices in Washington, D.C.

Robert F. Canaday, assistant to the vice president-market development, Douglas Aircraft Co., Long Beach, Calif. **D. C. Caldwell** succeeds Mr. Canaday as senior Washington (D.C.) representative for Douglas Aircraft Div.

Harlan W. Snyder, treasurer and controller, Canoga Electronics Corp., Van Nuys.

Joseph A. Kratovil, chief, Financial Management Div., NASA Manned Spacecraft Center, Houston, Tex., succeeding the late Rex Ray.

Brig. Gen. Harold K. Kelley, vice commander, Air Force Systems Command's Ballistic Systems Div., Norton AFB, Calif.

Dr. William Frank Hilton, English astronautical engineer, appointed secretary of the International Academy of Astronautics, Paris, France, and he will also act as executive secretary of the International Astronautical Federation.

(Continued on page 98)

INDUSTRY OBSERVER

▶ Advanced Gemini spacecraft which would require a Titan 3A booster is being considered by National Aeronautics and Space Administration. Aerojet transtage of the Titan 3A could be used for orbiting maneuvers.

▶ Feasibility tests of the laser tracking system to be used for ranging against NASA's S-66 polar ionosphere satellite have been conducted at Wallops Island. The laser ranged successfully off corner reflector panels hung between the landing gear legs of low-speed aircraft. Typical test range was 20,000 yd.

▶ Rocketdyne's Solid Propellant Operations Div., McGregor, Tex., appears to be the favorite to get the propulsion system contract on the Phoenix air-to-air missile planned for the Air Force-Navy F-111 tactical fighter. Development portion of the contract is expected to total about $4 million. Hughes Aircraft, responsible for development of the missile system, is specifying case-bonding of the solid propellant; this will pose severe insulation problems because of missile temperatures during supersonic dash phases of flights.

▶ Contractor selection of the backup, mechanically throttled landing engine for the Apollo Lunar Excursion Module (LEM) is expected to be made by Grumman Aircraft, LEM prime contractor, by May. Bidders were briefed Mar. 14 and proposals are due Apr. 8. Competitors included Aerojet-General, Space Technology Laboratories, Thiokol's Reaction Motors Div., and United Technology Center.

▶ Watch for Navy BuWeps to switch support from the long-range Typhon surface-to-air, ramjet-powered missile to an intermediate-range version which may utilize a solid-propellant rocket motor. Program change may be made this summer; it could lead to large production of the missiles.

▶ Army Missile Command is considering initiation of follow-on project to the Sergeant surface-to-surface missile. The projected Missile C would have a range substantially greater than the Sergeant's 75-mi. reach, and would carry a heavier warhead. Advanced Pershing is also under consideration, projected to double the present 400-naut.-mi. range of the Pershing.

▶ Navy is conducting intensive in-house analyses of potential sea-based weapon systems involving advanced techniques which might be applicable in the 1970-80 decade to protect fleet operations.

▶ Curtiss-Wright is proposing a version of its rotating-combustion aircraft engine as a powerplant for counter-insurgency (COIN) aircraft and the Army attack helicopter (AW Dec. 10, p. 26; Feb. 18, p. 26). Curtiss-Wright engine has greater weight, but lower fuel consumption than gas turbine engines. Total installed weight of fuel plus engine favors a rotating-combustion engine as mission time increases, crossover point for typical COIN missions is about one hour.

▶ Lockheed-Georgia is proposing a VTOL version of the C-130 Hercules transport using wing-mounted podded lift engines to produce the necessary vertical thrust increment. Proposed engines have a design thrust/weight ratio well above 10:1.

▶ Deliveries of Westland Wessex Mk. 31 helicopters to Australian Royal Navy have slipped due to problems with the Gazelle powerplant. Australia had received 13 of 21 helicopters scheduled for delivery by Feb. 28, out of a total order of 29. Rolls-Royce, now responsible for the Gazelle after taking over Napier last year, said production had fallen behind schedule before the transfer to the Rolls engine division, but that a revised delivery schedule had been agreed to by Australia.

▶ Gemini spacecraft will be suspended at an angle of about 30 deg. from true vertical in its interim parachute recovery system. Purpose of the offset angle is to reduce the rate of change of deceleration experienced by astronauts.

▶ Advanced Research Projects Agency's high-acceleration booster (HIBEX) program (AW Mar. 25, p. 35) is scheduled to include a year of development followed by a large number of rocket evaluation launchings.

Washington Roundup

Soviet Sub Threat

U.S. intelligence experts have "somewhat increased [the] estimate of the [Russian] submarine threat since last year," Defense Secretary Robert McNamara told the House defense appropriations subcommittee. Concerning the threat, he said: "In ASW [anti-submarine warfare], I have one ground rule and that is that money is no limit whatever on research and development projects associated with increasing our ability to detect, track and kill Soviet submarines, including particularly Soviet missile launching submarines."

On another subject, McNamara told the subcommittee recently that "the profit rate is too low today on defense contracts on the average to induce the type of effort and the assignment of the type of resources which we need, namely the application of our most advanced scientific and engineering talents to our weapon systems developments" (see p. 21). He said waste in defense business was not due to excess profits, but to the lack of advance planning of projects by both contractors and the government.

New Research Watchdog

Rep. Melvin Price has realized a longtime ambition by being appointed chairman of a special House armed services research and development subcommittee that will keep an eye on military space activities. Rep. Price said one of the first things he will look into is the USAF Boeing Dyna-Soar project (see p. 36), which he wants to continue. Full committee Chairman Carl Vinson, whose group gained legislative authority over military research budgets last year, created the subcommittee. It is expected to be organized within the next two weeks.

Further changes in the organization of the office of defense research and engineering were presaged last week by the announcement that Dr. Chalmers W. Sherwin, vice president and general manager of the Laboratories Div. of the Aerospace Corp., will fill a new post titled deputy director for research and technology about June 1. Dr. Eugene C. Tilburn now holds the title of deputy director for research and information systems, and James H. Gardner holds the title of deputy director for engineering and chemistry. But insiders say there will not be any increase in the number of deputy director jobs.

To Tell the Truth

After 26 months of confusion, accompanied by complaints from newsmen and topped recently by criticism from senators investigating the TFX contract (see p. 26), the real Arthur Sylvester has decided to stand up. White House Secretary Pierre Salinger and Assistant Secretary of State for Public Affairs Robert Manning—or their deputies—have allowed themselves to be identified by name in references to their frequent press briefings. But Sylvester, who is assistant secretary of defense for public affairs, has almost always been simply "a Defense Dept. spokesman."

Sylvester told the House government information subcommittee recently that he had followed his policy of anonymity because "I wanted to be a little careful," and did not seek the publicity. He also told the subcommittee that charges of news management by Defense Dept. were "hogwash."

IATA Fare Dispute

Representatives of European governments that have national airlines flying the Atlantic met informally in Geneva late last week to try to hammer out a common policy toward the Civil Aeronautics Board's rejection of an International Air Transport Assn. proposal to reduce round-trip discounts (AW Feb. 25, p. 43; Mar. 25, p. 21). Decisions reached there were not expected to have any immediate impact on the fluid fare situation, but they could produce a concerted effort by European governments to have the U.S. reverse its stand. The Swiss government acted as host. Countries represented were France, Great Britain, Germany, Italy, Belgium, Holland, Spain and the Scandinavian countries.

One man's view on why there has been no controversy over NASA's choice of Boston as the site for its new electronics center comes from Boston's mayor, John F. Collins: "... Every unbiased American recognizes that its location in the Boston area is the only sensible decision. We are the center of the greatest science-oriented education area in the world. ... The multi-million dollar potential in the increase of productivity and the increase in the satellite business will make Boston once again the hub of the science universe, All-American city, and the research center of the free world."

Time For Xplanations

Following the censored transcript of the Senate TFX investigation is not always informative. The following question and answer serve as an example—The Chairman: "Let me get what you are talking about now. Point to the chart." Gen. Gregg: "The [blank] nuclear bombs where we have [blank] and [blank] and the [blank] and the next one just below that, [blank] and [blank], and the [blank] missile."

—Washington Staff

McNamara Tries to Steer TFX Questions

Defense secretary visits McClellan committee with attorney general; suggests new areas of inquiry.

By George C. Wilson

Washington—Defense Secretary Robert S. McNamara last week gave senators investigating the F-111 (TFX) contract questions with which to challenge military witnesses from his own department about their findings that Boeing's proposal was superior to the one made by General Dynamics Grumman.

This unprecedented step dramatized the all-out effort the Kennedy Administration is making to justify its award of the $6.5-billion F-111 contract to General Dynamics-Grumman after USAF-Navy source selection boards had recommended Boeing unanimously four consecutive times.

The questions, which Defense Dept. classified on security grounds, were given to the senators on Mar. 27, just before members of the source selection board began testifying. That same day both McNamara and Attorney General Robert Kennedy visited Chairman John L. McClellan (D-Ark.) to discuss the TFX hearings and hand him the questions. Observers theorized that Attorney General Kennedy went along to indicate the keen interest that his brother, President Kennedy, has in the TFX investigation.

The questions were designed to bring out that the General Dynamics airplane, because of changes made since the contract decision, would no longer be inferior to the Boeing proposal in such important operational areas as ferry range and bomb carrying capacity (AW Mar. 25, p. 24). Initial reaction on the subcommittee included a comment by Sen. Henry M. Jackson (D-Wash.) that "Defense is now conducting an evaluation after the fact."

Right at the beginning of the TFX hearings the McClellan committee disclosed that the Air Force had estimated the Boeing tactical fighter would have 1,100 naut. mi. more ferry range and be able to carry far more payload than the General Dynamics-Grumman proposal. Since this disclosure, Defense Dept. evidently has incorporated features of the Boeing design into the General Dynamics-Grumman one to make the two comparable operationally.

Originally, McNamara justified his decision mainly on the contention that the General Dynamics-Grumman design promised to be more economical to build because there was less variation between the Air Force and Navy models of the tactical fighter. He told the subcommittee on Mar. 13 that this condition and "demonstrably credible understanding of costs" would "understandably loom less important in the eyes of the source selection board than operational capabilities." But now McNamara is defending his choice on operational grounds as well.

This massive effort to justify McNamara's F-111 decision indicates the Administration at long last is resigned to a full Senate investigation of the award and has decided to publicize its position as fully as possible. The campaign also shows that the Administration is worrying that the general public has serious doubts about the wisdom of the award.

However, McNamara and President Kennedy struck different public poses in reacting to the McClellan subcommittee's investigation. On Mar. 20, McNamara said while testifying before the subcommittee that "there is a lot of harm that will accrue from this investigation. I cannot see any good that will accrue from it. I can see only harm."

At his news conference the next day, President Kennedy said: "I see nothing wrong with the Congress looking at these matters. My judgment is that the decision reached by Secretary McNamara was the right one, sound one and any fair and objective hearing will bring that out. . . . I have no objection to anyone looking at the contract as long as they feel that a useful function is served." At another point he said he did not suggest who should get the F-111 contract. "This was completely the Defense Dept.," the President said.

McNamara's voice cracked and he rubbed his hands together—but did not cry as reported in some press accounts—as he told the subcommittee: "Last night when I got home at midnight, after preparing for today's hearing, my wife told me that my own 12-year old son had asked how long it would take for his father to prove his honesty." Sen. McClellan replied: "I feel strongly about it too. I have been charged with about everything, and I have the same sentiment and feeling as you. But I have a duty to perform, and I don't think that I ought to shirk that duty."

Such emotional exchanges, which swung the subcommittee spotlight away from the technical basis of the F-111 contract award, ended with the first appearance of the members of the USAF-Navy source selection boards, who explained dispassionately to the subcommittee how they arrived at their preference for the Boeing proposal. These were the highlights:

- **Scoring system.** Brig. Gen. Almond T. Culbertson, vice commander of the Air Proving Ground Center of AFSC, said that in assigning the total of 1,000 points, one-third went to technical factors, one-third to operational aspects and the remaining one-third was divided among management, production, cost and logistic elements. He defined technical factors as "the analysis of how the proposal came in, how they solved the problem of meeting the requirement, whether they used conventional means, whether they went to means that we didn't have any experience with. It was a review of the total engineering proposal: the types of material they used, any new manufacturing techniques that they had in mind." Operational aspects covered how the aircraft would perform and logistic consideration primarily involved the cost of maintaining the aircraft once it was operating in the field.

- Maj. Gen. Robert G. Ruegg, commander of the Aeronautical Systems Div. of the Air Force Systems Command, said this scoring "is a very important tool," but not a decisive one. He said this weighted scoring loses its effectiveness when the scores of two competing proposals come out very close. "Since design information submitted in the proposal generates specific scores, but design is quite likely to change as development progresses, we do not depend on numerical scores alone to identify the best source." Judgment, not numerical scores, is the deciding factor in a tight competition, he said. Gen. Ruegg startled Sen. McClellan when he said: "We have prepared corrected information about the operational capabilities of the General Dynamics-Grumman design in ferrying range and bomb carrying capacity." He said the figures used by the committee were those supplied by the Air Force but added: "We made a mistake in some of the figures and I don't know where the mistake occurred but there was a mistake in the figures submitted to the committee." McClellan said these were "after the fact figures" which may not have been available when the decision was made to award the contract. Gen. Ruegg said the new figures were prepared sometime in the week of Mar. 17 by Col. Ron A. James, USAF deputy chief of staff for systems and logistics.

- **Navy's selection activity.** Rear Adm. Frederick L. Ashworth, Bureau of Weapons assistant chief for research and development, said that in the first source selection board appraisal the Navy said only the Boeing and North American Aviation proposals were acceptable. The only factor the Navy evaluated in the proposals was carrier compatibility. In this first appraisal, the General Dynamics-Grumman proposal "was unacceptable without major changes," he said. Adm. Ashworth said the important consideration in carrier compatibility is wind over the deck for both recovery and for launching." He said the General Dynamics-Grumman proposal "was ten inch in excess of the minimum requirements as stated in the work statement, while the Boeing one was 'much better.'" He said Boeing met the catapulting but not the arresting gear requirement, while "General Dynamics was considerably inferior in both of these categories" to Boeing. Boeing met the requirement for a 500 ft. per min. climb rate on one engine if need off while approaching the carrier for landing. He said General Dynamics-Grumman merit would have

USAF Accounting Shifts

Washington—Reforms in the accounting procedures of the Air Force evaluation groups are almost certain to be recommended by the Senate Permanent Investigations Subcommittee as a result of the current F-111 investigation.

Subcommittee staff interviews with members of the F-111 evaluation group at Wright-Patterson AFB have convinced the investigators that there is often very little mathematical support for the USAF cost estimates on major contracts like the F-111.

For example, Warner Wilson, head of the TFX cost team at Wright-Patterson, was unable in an interview with the subcommittee staff to document the Air Force estimate that the Boeing thrust reverser proposed for the F-111 would add about $69 million to the production cost of the aircraft. Thomas Nunnally, General Accounting Office accountant on loan to the subcommittee, is analyzing the basis for these and other Air Force cost estimates used in appraising research and production proposals submitted by contractors. The result of his study is likely to be recommendations for sweeping reorganization of the estimating procedure at Wright-Patterson.

Controversy Eclipses Basic TFX Probe Issue

Washington—Controversy steaming lately from what senators investigating the TFX award call intellectual arrogance and political naivete of civilian defense leaders has all but eclipsed a central issue for the aerospace industry.

The issue is whether the principle of awarding defense contracts to the lowest responsible bidder is being supplanted by the personal judgment of the civilian secretary of defense. The first step, in the view of Chairman John L. McClellan (D-Ark.) of the Senate Permanent Investigations Subcommittee, is to reconstruct events preceding the decision to award the contract to General Dynamics-Grumman rather than Boeing.

It may well be that the subcommittee will conclude that General Dynamics-Grumman was indeed the lowest responsible bidder, despite Air Force estimates that the Boeing proposal would cost $415 million less. Sen. McClellan insists he must get the facts "from the ground up" before his subcommittee can reach any conclusions. But Defense Secretary Robert S. McNamara and his colleagues keep disrupting the committee's own procedure by repeatedly crossing the jealously guarded line which separates the legislative and executive branches of the government.

First, McNamara asked to testify last so that he could rebut any charges made by witnesses called before him. Then he changed his mind. McNamara wrote Sen. McClellan that the investigation was undermining public confidence in the Defense Dept. and asked permission to file a statement explaining why he awarded the F-111 contract to General Dynamics-Grumman. The 32-page statement he filed ignored many of the substantive questions raised in the subcommittee hearings. Later, McNamara crossed the line twice again by asking to testify in person and by supplying questions to the senators for other witnesses (see story). Senators especially veterans like Sen. McClellan, have been antagonized by advice from the Executive Branch about how to run a legislative hearing.

Even more irritating to the senators was the charge by Arthur Sylvester, assistant defense secretary for public affairs, that the subcommittee could not conduct a "judicial" inquiry because of the stake that the members states have in the F-111 contract. Sylvester could not substantiate the charge when called before the subcommittee. admitted he had not read the transcripts of the hearings thoroughly and had never heard of John Stack, a widely recognized authority on aeronautical engineering whose research helped develop the variable sweep wing design that is the heart of the F-111 concept. Roswell L. Gilpatric, deputy secretary of defense, further inflamed the senators by criticizing the subcommittee without letting his name be used. He, too, was called up before the subcommittee and denied he meant to imply the inquiry was unfair.

All these attacks from civilian Defense Dept. leaders have stiffened the resolve of subcommittee members to continue the investigation even though the inquiry is obviously troubling the President. But as one senator put it: "His boys are the ones who put the investigation on the front pages by attacking us." Emotional ties between senators are much stronger in such a situation than party ties between Congress and the White House. This emotionalism has led to claims that the fight really stems from a basic dispute between military and civilian officials in the Defense Dept. However, the strongest testimony against McNamara's decision has been that given by two civilians, Stack and George Spangenberg, evaluation division director at the Bureau of Naval Weapons. Stack disputed the major technical objections raised by Air Force Secretary Eugene M. Zuckert to the Boeing design, while Spangenberg called the TFX project requirements "irrational" (AW Mar. 18, p. 26).

Since they testified, McNamara has been fortifying his position with fresh facts and figures, including new performance estimates which would remove the operational edge the military sees in the Boeing design. But this new information will be examined closely to see if the improvement is attributable to using what McNamara said were objectionable features in the Boeing design.

Sen. Henry M. Jackson (D-Wash.), who requested the F-111 investigation in the first place, insists all this information must be developed to determine whether the basic principle of awarding the contract to the lowest responsible bidder has been observed. A point still to be explored is that the F-111 contract is an incentive type which would penalize the contractor if his bid was too low. This may challenge McNamara's contention that Boeing's cost estimates were unrealistic.

Pentagon News Leaks

Washington—Defense Dept is making "strenuous efforts to manage the leaks" of information to the press Secretary Robert S McNamara told the Senate Permanent Investigations Subcommittee while decrying the publication of an Air Force report claiming that F-111 (TFX) investigators had abused witnesses (AW Mar 25, p 25)

He said he has been distressed by 15 or 20 news leaks in the last 26 months "I became so upset about the situation that on several occasions I have discussed it with the attorney general and J Edgar Hoover director of the Federal Bureau of Investigation," he said

McNamara said the Air Force complaint about the subcommittee staff's treatment of Defense Dept witnesses was an internal report that he saw Mar 14 and promptly ordered to be locked in a safe for fear of disrupting the F-111 investigation But portions of the report were published in the Washington Star Mar 21, the day McNamara testified before the subcommittee "I must say I almost had indigestion at lunch time," McNamara said in describing his reaction to publication of the Air Force complaint

McNamara ordered Air Force Secretary Eugene Zuckert to investigate the leak, and Zuckert assigned the task to Lt Gen William H Blanchard, USAF's inspector general Investigators questioned the Star reporter who wrote the story, even though Assistant Secretary of Defense for Public Affairs Arthur Sylvester said Defense Dept has a policy against questioning reporters about their stories. Sylvester, who was quoted in the story, was also questioned by Gen Blanchard. Sylvester said the FBI is not involved in the investigation

had a "zero or less than zero rate of climb under those circumstances." Most important change needed in the Boeing design in the Navy's view was to replace the General Electric MF 295 engine with the Pratt & Whitney JTF 10A-20, Adm Ashworth said This was done after the first evaluation of the F-111 proposals (AW Feb 12, 1962, p 28). Adm Ashworth said the engine substitution was advocated by the source selection board because "it was generally recognized that the General Electric engine at this stage was a very high risk that it would not have been developed in time to meet the airplane development program because it was, indeed, an undeveloped engine"

Asked why he voted for Boeing in the first evaluation, even though the design did not meet all the Navy's requirements, Adm Ashworth said the Air Force source selection procedure is one to select a source and not necessarily a design "I was willing as the Navy voting member [of the source selection board] to select Boeing as the contractor, recognizing that there were changes in the design which he had proposed which needed to be made in order to make an acceptable aircraft for Navy use," he said

Ordinarily the Navy would have refined the design first and selected the source second

Jerome Adlerman, subcommittee chief counsel, placed in the record a June 5 letter to the source selection board directing both Boeing and General Dynamics-Grumman to study ways to reduce the weight of the Navy versions of the F-111 at the expense of similarity or commonality This letter, from Maj Gen W Austin Davis former commander of USAF's Aeronautical Systems Div came after the second evaluation, when Navy felt that the designs of both of the airplanes had deteriorated

• **Single source was sought.** Gen Culbertson said the source selection board believes its responsibility is to select a single source as soon as possible to reduce the design workload on industry The Board recommended Boeing as the source after the first evaluation while the evaluation group—a large body which analyzes the various contractor proposals for the board—recommended that the competition be continued between Boeing and General Dynamics Grumman so the designs could be perfected further Air Force Secretary Eugene M Zuckert and Navy Secretary Fred Korth, with the concurrence of McNamara, ordered the evaluation group's approach

• **Production contract** Gen Ruegg said the cost estimates submitted by the contractors and adjusted by the Air Force are not especially crucial since they will not be used as the basis for the production contract He said Defense Dept plans to place the first production contract for the F-111 in 1965 Detailed cost history will be generated in the meantime which can be used as a basis for the production contract, he said

Douglas Rejects Merger Offer

Douglas Aircraft Co directors and management have rejected an informal merger proposal from McDonnell Aircraft Corp as not in the best interests of Douglas or its stockholders

Terms of the proposal were not revealed but one probable stumbling block would be an equitable stock exchange that would satisfy both Douglas and McDonnell stockholders

Market price of Douglas stock last week was about $23 a share, but book value of the stock was $34 46, according to the Douglas annual report issued last week McDonnell, on the other hand, reported a book value per share of $24 14 at the end of its last fiscal year, but the stock was selling last week at $52 $53 per share

McDonnell Board Chairman James S McDonnell Jr, owns more than 100,000 shares of Douglas stock a holding far larger than that of the 5,454 shares of Donald Douglas, Sr, or the 1,082 shares held by Donald Douglas, Jr Total shareholdings of all Douglas directors is 10,122

Substantial holdings also are listed nominally in the hands of large brokerage firms, either owned by the brokers or held for customers Merrill, Lynch Pierce Fenner & Smith because of its size, is probably the largest such holder, and Donald Douglas, Jr, was in New York last week to discuss the outlook for Douglas with the brokerage company

Total income reported by Douglas last week for 1962 was $757,394,716, a decline from 1961's figure of $794,730,690 Earnings were almost doubled, however rising from $5,956,909 in 1961 to $10,205,248 last year as the effect of the heavy losses on the DC-8 jet transport program began to fade Douglas delivered 22 DC-8s in 1962 and had orders for 25 at the close of last year

Backlog for Douglas at year end, after allowance for cancellation of the Skybolt air-launched ballistic missile was $806 million, compared with $759 million a year earlier Of the total, $160 million was for commercial work, $205 million for missile programs, $203 million in space programs and $236 million in military aircraft and other military programs

Other major aerospace companies reporting 1962 results last week included the following

	1962	1961
Aerojet-General Corp		
Sales	$ 604,800,000	$478,402,078
Earnings	13,507,003	11,768,040
Fairchild Stratos		
Sales	70,289,000	76,008,000
Earnings	3,057,000	3,190,000
General Precision Equipment Corp		
Sales	222,602,328	234,020,401
Earnings	4,373,504	6,321,109
Grumman Aircraft Engineering Corp		
Sales	387,300,077	317,300,855
Earnings	9,246,000	9,107,088
Backlog	310,000,000	205,600,000
(Grumman is negotiating an additional $200 million in orders)		
Ling-Temco-Vought		
Sales	335,430,130	192,847,111
Earnings	6,050,000	
(Loss)		(10,130,001)
Backlog	362,962,000	332,162,000
(The 1961 Ling-Temco figures include only the four months of consolidated operation with Chance Vought after the acquisition in September 1961.)		

Workers Vote on Final Boeing Proposal

Washington—Approximately 40,000 Boeing Co workers from Seattle to Cape Canaveral will vote Apr 2-4 on a final contract package proposal by the company

International Assn of Machinists, with a membership of approximately 30,000, is urging rejection of the offer

The 80-day Taft-Hartley injunction which has prevented a strike at Boeing, expires Apr 15 National Labor Relations Board will conduct the election this week, and hopes to have the result by Apr 8—a week before the firm is confronted with a walkout of workers

In the nine cases over the past 15 years in which a final company offer has been made under Taft-Hartley terms, workers have overwhelmingly rejected it

Explaining the Boeing offer sent to all wage earners last week, Boeing Vice President Lowell P Mickelwait stressed pay increases and job security Ed Springer, coordinator of the IAM negotiating team, replied that wages per se are not a major issue

The company and union proposals at least approach agreement. The three major issues in the dispute are not satisfactorily covered in the company's final proposal, Springer said They are:

• **Job evaluation.** He said Boeing is using an out-dated 1943 formula for evaluating jobs Manip because of this "manipulation," Springer charged that Boeing wages are below the rest of the aerospace industry and job inequities are widespread

• **Performance analysis.** Springer said that Boeing is the only company in the aerospace industry which is using "this unfair system, which, in effect, destroys the seniority system"

• **Relocation pay** Boeing is the only aerospace company that has refused to write a clause into a labor contract for travel and relocation pay for employes shifted to missile or other sites Springer said "In effect the company wants to bargain individually with each employe," he said

IAM apparently is willing to settle for something less than the union shop adamantly opposed by the company even though a presidential board and the overwhelming number of Boeing employes have supported the union shop (At an election last December, 74% of Boeing workers supported a union shop (AW Dec 24 p 22) A board chaired by Saul Wallen said, in a report to the President that if the board members were arbitrators they would decide for a union shop at Boeing (AW Jan 7, p 30)

The union shop would require all workers to join the union Springer said that IAM realized that Boeing had an obligation to non-union workers who did not join in a 1948 strike against the company

IAM's willingness to negotiate with the company on the union shop principle probably is due also to the fact that the union has grown strong without the membership requirement

Boeing also has numbers in right to work states in which the union shop is illegal

On job security, Mickelwait wrote workers

"The company is exerting every effort to provide continuous employment However the loss of competitions such as the TFX, the possible cancellation of existing business and the increasing competition both domestic and foreign must make it clear that the company is facing difficult times in acquiring new business and in maintaining present levels of employment The company offer reaches and perhaps exceeds the limit to which the company should go if there is to be a reasonable chance of providing continuity of employment"

Meanwhile political pressure against Boeing management mounted

Washington's Democratic governor, Albert D Rosellini, in a formal, signed declaration, and the state's Democratic-controlled Senate in a resolution called for settlement on terms acceptable to the union

The governor's statement urged the company and union to settle their dispute either by accepting the Wallen board's recommendations or "through impartial and binding arbitration" On the Wallen board, it noted "this impartial panel of distinguished citizens completed its study and made recommendations that proved to be acceptable to the union but were refused as a basis of further negotiation by the company" IAM has also been willing to submit the case to arbitration

The state Senate's resolution called for settlement according to the Wallen board recommendations, after making several observations reflecting favorably on the union

The state's Republican-controlled House took no formal action in connection with the Boeing labor controversy

The state Senate's resolution noted that IAM, "being fully cognizant of the importance of the continued and uninterrupted production at Boeing has been attempting, since last July 15 to negotiate a labor contract with the company that will avoid any economic difficulties and has, on two occasions at the request of the government extended its former agreement to avoid a work stoppage . . ." It also noted IAM was willing to accept the Wallen board findings or binding arbitration It then called on IAM and Boeing management "to demonstrate their responsibilities and mutual obligations and abide by the recommendations" of the Wallen board

Firms Balk; Data-Sharing Clause Dropped

Washington—Navy faced with refusal by some firms to accept data-sharing requirements that radically depart from current armed services procurement regulations has canceled a special clause which had been added retroactively to requests for proposals for its regenerative turboprop engine (AW Mar 25, p 33)

Of the six companies that received the requests for proposals (RFPs) for Project 2995 three had indicated that their proposals would contain strong objections to what they term the "give away" clause and that they would refuse to accept it

Allison Pratt & Whitney and General Electric all said that they would be required to pass on to possible future competitors the results of their private investment which produced "know how" and proprietary development and manufacturing methods Curtiss-Wright and Lycoming said they would accept the data requirements clause

AiResearch, which also received the RFP had offered its heat recapture knowledge to each of the five other companies but now has made an exclusive rights arrangement with Curtiss Wright For the regenerative turboprop engine (RTE) competition proposals it will be teamed with Curtiss Wright

Navy intends to use the RTE engine which would have a fuel consumption factor of 0 3 lb /hp /hr- closely approximating that of the turbo-compound reciprocating engine for a wide variety of aircraft installations

At present the Allison T56 turboprop is installed in the Lockheed P 3A the Grumman E 2A carrier based an intercept control aircraft and the Navy version of the C-130 transport aircraft For the future, RTE will be used in all Navy designs for heavy lift aircraft in which endurance and range are more desirable than speed

The RTE would recapture heat from the jet exhaust and transfer it to the air coming from the compressor, improving the efficiency of the burner section

Alaskan Air Commander Disputes Official Version of Soviet Flights

By Larry Booda

Washington—Apparent major discrepancy between what actually happened and what the U.S. government reported to the public about the recent flight of two Russian aircraft over Alaska appeared last week.

Information released by government agencies (AW Mar. 25, p. 22) made it appear that the flight over U.S. territory was deliberate. But information obtained by AVIATION WEEK & SPACE TECHNOLOGY indicates that the two aircraft were lost, and that when they sighted land they immediately increased speed and turned seaward away from Alaska.

The commander-in-chief of the U.S. Alaskan Command, USAF Lt. Gen. George W. Mundy, has protested that the information he passed to the Defense Dept. was completely garbled in the versions released to the public. State Dept. said it used only the information given to it by the Joint Chiefs of Staff when it prepared a note of protest to Russia. The note was sent on Mar. 16. Defense Dept. has offered no explanation of the discrepancies.

The note of protest, which was cleared at the highest levels of the government, gave specific times and the latitudes and longitudes of the penetration and departure of each aircraft.

The note said that the first aircraft entered U.S. territory at 9:05 p.m. Alaskan time at 59 deg. 52 min. N. and 163 deg. W., and departed at 9:30 p.m. at 60 deg. 18 min. N. and 166 deg. 40 min. W. The second aircraft entered at 9:13 p.m. at 59 deg. 50 min. N. and 163 deg. 10 min. W., and departed at 9:34 p.m. at 61 deg. 10 min. N. and 165 deg. 40 min. W., the note said.

Thus one aircraft was claimed to have been over U.S. territory for 25 min. and the other 21 min. Depth of penetration was 30 mi., the note said.

The original draft of the note passed to U.S. Ambassador Foy D. Kohler said: "The depth of penetration and duration of the over flights indicated this was a deliberate act on the part of the Soviet aircraft." This sentence was deleted from the note released by the State Dept. which it said was passed to the Soviet first deputy foreign minister.

The information originally passed from the Alaskan Command that the two Soviet aircraft were picked up at the maximum possible distance over the water by radar. Two Convair F-102 delta-wing fighters were scrambled from the Galena Airport in the Yukon Valley. They headed toward an intercept.

The two Soviet aircraft flying some distance apart, approached land under a low overcast, according to the command. As soon as the first one saw land he immediately increased his speed from over 300 kt. to 450 kt. and turned away from land. The second aircraft continued further before taking action to get away, passing inland only a short distance—far short of 30 mi.

In the meantime, a second two-plane element of F-102s was scrambled from Galena. The first element made an intercept, the Defense Dept. said. The definitions of intercept vary, which in this case, it means that radar contact was made by the fighters, but they did not get close enough to launch their Hughes Falcon GAR-9 air-to-air missiles or sight the Soviet aircraft.

Thus the major variations in the situation are reported by the Alaskan Command and as released publicly are the time the Soviet aircraft spent inside U.S. territory—that is over land or inside the 3 mi. limit or bay area claimed as U.S. territory—and the altitude. The situation reported by the command would indicate that the aircraft flew over U.S. territory for a very few minutes, and their actions plainly indicated that they blundered into the restricted area through navigation error.

If the Soviet aircraft had penetrated further and a full intercept within attack range had been made, the aircraft would have been shot down. Current orders are unequivocal in this respect. The Alaskan commander has orders to shoot down over-flying aircraft without recourse to higher authority.

Soviet flights along the borders of Alaska have been commonplace for many years. In most instances they are performing "ferret" missions, gaining electronic intelligence on radars and communications.

There also have been some penetrations by high-altitude, high-speed reconnaissance fighters. None of these has been intercepted and shot down.

The Russian ferret and reconnaissance flights resemble those conducted along the periphery and over the Soviet Union for many years by Air Force and Navy aircraft.

Air Defense of Alaska is assigned to the 317th Fighter-Interceptor Squadron (Reinforced). It is divided between Elmendorf AFB, which is south of the Alaskan mountain range, and Eielson AFB, north of the range. Alert elements are stationed at two forward fields at King Salmon on the Alaskan Peninsula and at Galena. Aircraft and crews are rotated for duty at these fields.

Detection radar coverage of Alaska is almost complete as far as northwest-to-southwest approaches are concerned. The Dew Line protects the north. Ground Control Intercept stations direct fighter aircraft to targets.

Some Alaskan officials have complained that the state is not sufficiently protected from air intrusion and attack. The Air Force says that the F-102s are fast enough to intercept and shoot down the types of Soviet aircraft now being encountered.

Russia Rejects Protest

Washington — Authoritative U.S. sources last week said that a firm rejection to the U.S. note of protest about Russian flights over Alaska (see story) has been received from Russia. The note they said claimed that flights have come no closer than 350 km. (217 mi.).

Comsat Corp. Stock Sought by 53 Firms

Washington—Fifty-three communications companies had filed with Federal Communications Commission for authorization to purchase common carrier stock in Communications Satellite Corp. by late last week.

This does not necessarily mean they will purchase stock in the new firm now being organized (AW Mar. 25, p. 28).

The firms include American Telephone & Telegraph Co., International Telephone & Telegraph Corp. and RCA Communications, a subsidiary of Radio Corp. of America. General Telephone & Electronics Corp. was the only large carrier that had not filed.

Random-Orbit Satellite

Contractor selection in USAF's Space Systems Div.-sponsored competition for the random-orbit communications satellite is expected to be announced about May 1. As many as five contracts may be awarded for the initial two-month program definition phase.

Estimate is that at least 20 satellites will be required for adequate communications in random, 5,000-nautical mi. polar orbits. Deployment of 23 satellites would afford a 99% probability of communication capability by having at least one satellite "in view" for transmission.

Critical factors in achieving proper satellite dispersion include launch window, separation of orbital planes, and successive ejection of several satellites from a single dispenser with a velocity increment of as little as 1 fps.

Apollo, Gemini to Cost $4 Billion Yearly

By Alfred P. Alibrando

Washington—Cost of civilian manned space flight programs will increase to about $4 billion a year in Fiscal 1965 and 1966, D. Brainerd Holmes, director of the U.S. space agency's Office of Manned Flight, told Congress last week.

National Aeronautics and Space Administration is asking for $3.7 billion in new obligational authority in Fiscal 1964 for facilities and research and development. During hearings on this request before the House space committee's manned space flight subcommittee, Holmes said the Gemini and Apollo flight programs and early work on a lunar logistics vehicle, manned space stations and manned planetary flight programs would require a $4 billion-a-year spending level in the following years.

Holmes said the current estimate of the total cost of the "hard-core" Apollo manned lunar flight program is $20 billion or less. This total, he said, does not include the cost of supporting unmanned missions. He estimated that about $4 billion will have been spent or obligated through Fiscal Year 1963.

Subcommittee members expressed some concern that multi-billion dollar facilities being built at Cape Canaveral for Apollo will not be used after the lunar landing flight program ends.

Holmes assured the subcommittee that the facilities would be used and predicted that launch activity in the 1970s, following Apollo probably would increase as the U.S. moved into more ambitious manned and unmanned planetary and interplanetary flight programs. He said it might even be necessary to expand Hevomi the 80,000-acre facility being built for Apollo.

Hearings on the manned flight budget request were adjourned after one day to permit NASA time to prepare a report on what the agency requested in Fiscal 1963, amounts appropriated for specific items and expenditures or amounts obligated.

Rep. Olin E. Teague (D.-Tex.), subcommittee chairman, has maintained that the House space committee cannot expect Congress to support NASA's growing budget unless the committee can give the legislative body some assurance that the expenditures are necessary and well-managed. He said the subcommittee must have some basis for beginning an examination of the Fiscal 1964 budget request, and that basis is a complete understanding of how Fiscal 1963 funds were spent.

In manned flight subcommittee hearings on NASA's procurement policies and practices, Rep. Teague said he was "receiving an increasing number of complaints from industry" on the agency's selection of contractors. Other members of the subcommittee said they received similar complaints concerning NASA's university grant program.

Albert F. Siepert, director of NASA's office of administration, offered to forward such complaints to the agency's inspections division or refer them for independent review outside NASA. Rep. Teague said he had some reservation about most of the complaints received so far because those persons bringing them refused to permit their firms to be named.

In other hearings last week, Dr. S. Fred Singer, director of the Weather Bureau's National Weather Satellite Center, told the House space subcommittee on applications and tracking that the launch of Tiros 7, scheduled for the first quarter of 1963, had been postponed because Tiros 5 and Tiros 6 were still transmitting good cloud cover pictures. He said Tiros 7 probably will be launched in August or September.

One aspect of the tentative U.S.-Soviet weather satellite program agreement (see p. 36) that bothered subcommittee members is the lack of a requirement for turning off the U.S. satellite in event of war with the USSR.

Singer said the Defense Dept. has not requested such a capability and that by the time a cooperative system is in operation the Russians probably will have their own weather satellite system "so that in the long run it may not be necessary to turn things off."

NASA's proposal to build an Electronics Research Center in the Boston area was examined closely in hearing by the subcommittee on advanced research and technology. Members of the House space committee have expressed some skepticism over the need for the facility.

In a lengthy letter Mar. 21 to Rep. George Miller (D.-Calif.), chairman of the committee, NASA Administrator James E. Webb sought to explain the justification for both the need and site.

Webb wrote Miller that by 1961 "it was clear that the existing base was not adequate to the growing electronics requirements." Webb pointed out that "electronic components account for over 40% of the cost of our boosters, over 70% of the cost of our spacecraft and over 90% of the cost of ... tracking and data acquisition."

In a follow-up letter last week to Miller and Sen. Clinton P. Anderson (D.-N.M.), chairman of the Senate space committee, Webb said that "over the last day or two, it has become clear that the development of a mid-city location utilizing air rights over land now owned by the Massachusetts Turnpike Authority may provide an alternate to our earlier plan ..."

COIN Powerplant

Washington — Negotiations between the office of the secretary of defense and the Navy's Bureau of Weapons on specifications for the light counter insurgency aircraft (AW Feb. 18, p. 38) have narrowed to price and powerplant.

Bureau of Weapons maintains that if a new engine is developed, the price of the aircraft will far exceed the $100,000 target. However, one engine that is in the last stages of development and two others nearing the last stages are being considered by several aircraft companies.

The engine nearest to completion is the Allison T63 free turbine which was developed to provide a minimum of 250 hp. for the Army's light observation helicopter competition. It is now flying in prototypes of three helicopter manufacturers.

Chance Vought and Lockheed are proposing use of an uprated version of the T63 producing 290 hp. with four engines—two powering each propeller. The necessary horsepower could be reached for takeoff, landing and high speed operation. For loiter and low speed, one engine on each side would be shut down.

Similarly, the Continental T65 which is also free turbine type and is the back up engine for the T63 in the LOH installation, is being considered by at least two airframe manufacturers. Twin installations would also be used.

YAT-28E Crashes

North American's YAT-28L counter insurgency aircraft crashed on its 14th test flight near Logan, Ohio, while performing structural test maneuvers.

Following two dives from 20,000 ft. with 3g and 4.5g pullouts, the airplane had entered the third maneuver on the test flight: a diving right turn with a 30 deg. nose-down attitude and a 45 deg. bank that was to end with a rollout and pullup at a maximum of 3½g. Instead the bank steepened to 60 deg., then 90 deg. and finally the airplane went over on its back. Pieces then began coming off the tail, and the airplane entered what appeared to be a flat spin.

Plane was flown by George W. Hoskins, 39, chief test pilot for North American's Columbus Div., who was killed.

Only one aircraft was built in the program, and the program's future was not clear in the wake of the crash.

Saturn Shows One-Engine-Out Capability

By George Alexander

Cape Canaveral, Fla.—Capability of the Saturn 1 booster stage to fly on seven of its eight engines was demonstrated successfully here last week by the fourth research and development vehicle—SA-4.

Engine No. 5, one of four inboard powerplants was shut down by a preset timer after 100 sec. of flight. Propellants that normally would have been consumed by this Rocketdyne H-1 engine were cross manifolded to the other seven H-1 engines extending their burning time by 2 sec. and thus compensating for loss of that engine's thrust.

Normal cutoff times for the eight engines consuming 625,000 lb. of propellants, would have been 112 sec. for the inboards and 119 for the outboards. Instead the inboards shut down at 114 sec. upon command of a timer and the outboards continued until 121 sec. when all oxidizer was depleted.

Preliminary data analysis at the launch site indicated that the two accelerometers which will provide the primary pitch and yaw signals to the operational Saturn 1 guidance system worked well. Flown for the first time and mounted on the spider beam assembly at the top of the booster, the sensors operated closed loop, i.e., they actually controlled Saturn SA-4 along these two axes. Roll control was provided by the ST-90 stabilized platform.

SA-4 was launched at 3:11 p.m. EST Mar. 28 after experiencing three holds totaling 101 min. First hold for 19 min. was caused by a check of the ST-90 platform gyro stabilization. Second hold for 40 min. was caused by a faulty theodolite requiring replacement and recalibration of telemetry systems. Third hold for 42 min. was caused by an indication of a faulty microswitch in the automatic sequencer which might have terminated an otherwise normal countdown.

Marshall Space Flight Center of the National Aeronautics and Space Administration had considered shutting down one of the outboard engines, (AW Nov. 26, p. 32) which are gimbaled to provide flight control, but instead decided on a rigidly fixed inboard powerplant for several reasons.

• **Performance to two flight-controlling** accelerometers, replacing angle-of-attack sensors flown on previous Saturns, was a paramount test objective. These accelerometers mounted in the pitch and yaw planes, sensed deviations from the pre-planned trajectory and sent corrective signals through the guidance computer to the control engine actuators. Had one of the control engines been shut down it would have induced extraneous inputs for these sensors when only normal flight inputs were desired.

• **Engine-out experiment** was predicated upon minimum jeopardy to the over-all flight mission. It was therefore decided to shut down one of the engines toward the end of the flight when, if catastrophic failure ensued, most of the test objectives would have already been met. At the altitude selected for the engine cut test, about 110,000 ft., there is too little atmosphere in which to ascertain the effectiveness of a control engine.

At time of shutdown of engine No. 5, Marshall engineers expected that about 85,000 lb. of RP-1 fuel and liquid oxygen would remain in the S-I's nine tanks. There are eight 70-in.-dia. tanks, four for RP-1 and four for liquid oxygen, clustered around a central 105-in.-dia. liquid oxygen tank.

Fuel tank No. 1 supplies RP-1 to both outboard engine No. 1 and inboard engine No. 5. When the latter was shut down, the RP-1 was expected to transfer through cross-manifolds interconnecting the bottoms of the four fuel tanks to the other seven engine pump inlets. Same procedures were used with transfer of the liquid oxygen. System was expected to stabilize within 10 sec. after shutdown of engine No. 5.

Marshall engineers were concerned about the possibility of the dead—and consequently uncooled—engine disintegrating under the heat generated by the other engines but believed that No. 5 would survive. Temperature sensors were mounted on the rim of No. 5's nozzle, however, to determine the extent of heating. Back flow of exhaust gases from the other engines on to the engine compartment shield, through the gap created by a dead engine was not believed to be as severe a problem as first envisioned. A new insulating material was applied to some of the panels in SA-4's shield for evaluation purposes.

Saturn Earth Orbit

Cape Canaveral—First live Saturn S-4 upper stage will be injected into a 120-150 mi. earth orbit at the next Saturn launch, that of Saturn SA-5 in August, Wernher von Braun, director of the Marshall Space Flight Center, revealed here following the successful SA-4 launch last week. Weight of the spent stage, 11,000 lb., guidance and control unit module, 4,000 lb., and dummy payload, 18,000 lb., totaling approximately 33,000 lb., would be the largest weight placed in orbit by the U.S.

Some experiments and changes were flown on SA-4.

• **Dummy ullage rockets,** chill down hydrogen ducts and a cable trunk tunnel were added to the mett S-4 second stage and inter-stage of SA-4. These components are essential to a live S-4 stage but served no useful purpose on SA-4 other than to simulate the Block 2 configuration of the S-1 stage. SA-4 was the last Block-1 configuration to be flown.

• **Four solid propellant retrorockets** on the S-1 booster stage were fired 12 sec. after shutdown of the inboard engines, as on SA-3 last Nov. 16. The firing of these rockets was really not necessary, as there were no live upper stages on this flight. A small tape recorder stored data during the temporary blackout in communications caused by exhaust of the retrorockets and played it back later to ground stations.

• **Prototype of the ST-124** stabilized guidance platform was flown open loop, as it was on SA-3 last fall. Actual guidance signals were derived from the modified ST-90 platform taken from the Jupiter IRBM. ST-124 will not be flown closed-loop until SA-7.

• **Radar altimeter** was flown for the first time on an experimental basis. It is expected to be used operationally on Saturn 5 launch vehicles.

• **Mistram** (missile trajectory measurement) transponder was carried to assist the Atlantic Missile Range in the development of this General Electric Co. tracking system.

• **Q-ball** angle-of-attack sensor similar to that flown on the X-15 aircraft, was used for the first time in the apex of the SA-4 nose cone. Contained in an 18-in. cone and mounted on the regular Jupiter nose cone by means of an 18-in. adapter section, the complete package was 36 in. high, making SA-4, at 165 ft., 3 ft. taller than previous Saturn vehicles.

SA-4 carried 617 in-flight measurements, compared with 607 aboard SA-3, 526 on SA-2 and 505 on SA-1. During the countdown, 102 blockhouse measurements were taken.

SA-4, carrying dummy, water-filled S-4 and S-5 stages and a dummy nose cone, was programed to be launched on an azimuth of 100 deg. The vehicle was to begin pitching over at about T+10 sec. and continue until about T+105 sec. when it would be inclined 43 deg. from the launch vertical. Maximum altitude expected was 77 mi., compared with an average of 85 mi. on earlier Saturn flights, and range was expected to be about 230 mi. Liftoff weight of SA-4 was about 940,000 lb., approximately the same as SA-1 and SA-2 but 125,000 lb. lighter than SA-3.

Nova, Post-Nova Studies Submitted to NASA

Nova vehicle studies being performed by Martin-Marietta and General Dynamics/Astronautics and post-Nova studies performed by Douglas Aircraft and General Dynamics/Astronautics are being submitted to NASA's Marshall Space Flight Center this month. Boeing, which also performed a Nova study, submitted its results earlier, as did Rand Corp., which analyzed costs for various configurations of the post-Nova vehicle.

For utilization of solid propellants, the Martin Nova study considers a cluster of four 260-in.-dia. motors topped by a liquid-propellant engine stage to boost payloads in the order of 800,000 lb.

The General Dynamics/Astronautics Nova study considers a cluster of four 325-in.-dia. solids plus a liquid propellant engine for the second stage.

Both companies also considered all-liquid engine configurations, which probably included use of the Rocketdyne F-1 liquid-oxygen/RP engine for the first stage, and a liquid-oxygen/hydrogen engine for the second stage.

Boeing study considered only solid propellant clusters for first stage of Nova. Under a separate contract, Martin-Denver is studying Nova launch facilities.

Post-Nova studies generally have the same 1-million-lb. payload specification limit as the Nova studies, but are based on a more unconventional approach with regard to staging, engine type, and recovery modes. Both the Douglas and General Dynamics/Astronautics post-Nova studies include reusable single-stage-to-orbit liquid propellant engines utilizing plug nozzles. Use of the F-1 in the post-Nova studies was not a requirement.

Solid propellant motors considered in the post-Nova studies would be used only as strap-on units, similar to use in the Titan 3C and thrust-augmented Thor configurations (AW Mar. 18, p. 36).

Apollo Guidance Computer Design To Permit Checkout During Flight

New York—Apollo guidance computer is being designed to permit in-flight performance checkout and trouble shooting, with a provision for replacement of malfunctioning modules with spares carried in the spacecraft, according to Elliot Lee, one of the nine second-generation astronauts.

Lee said the digital navigation computer will be the primary source of orbit and trajectory calculations during the entire flight. He reported on the computer here last week to the Institute of Electrical and Electronic Engineers (IEEE) professional group on aeronautical and navigational electronics.

Immediately after an earth orbit is achieved by the Apollo spacecraft, Lee said the crew will use a space sextant to take star fixes and calculate their position. This data will be fed manually into the computer, which will make an orbital calculation prior to firing the third stage for a second time to reach escape velocity.

In addition to performing midcourse guidance, the computer will also calculate the precise instant to apply the braking rockets to put the spacecraft into lunar orbit and later to calculate the return trajectory and the optimum point of earth re-entry, Lee said.

Computer, being developed by the Massachusetts Institute of Technology Instrumentation Laboratory, will use microcircuitry throughout and will use a rope-core fixed memory and ferrite plane erasable storage.

National Aeronautics and Space Administration's Manned Spacecraft Center currently is investigating gallium-arsenide lasers in the hope that the device can be used for some Apollo communications and guidance functions with significant potential savings in payload size and weight, Lee reported.

Problems which must be solved before the laser can be used for Apollo include maintaining the laser diode at extremely low temperature to achieve coherent light output, precision pointing techniques and suitable receiver and modulation techniques.

S-6 Postponed

Cape Canaveral, Fla.—National Aeronautics and Space Administration will attempt to launch the S-6 atmospheric structure satellite again this week after a faulty experiment aboard the satellite postponed the first attempt last Thursday. The satellite, to be designated Explorer 17 if successful, will measure the density, composition, pressure and temperature of the atmosphere between the altitudes of 155 and 580 stat. mi.

Mass spectrometer, one of two identical units designed to detect helium and both atomic and molecular oxygen and nitrogen in space, had to be replaced.

See, whose areas of specialization in the new group of astronauts include spacecraft electrical and sequential systems and mission planning, said the main electric power in the spacecraft will be provided by three fuel cells.

Any two cells are sufficient to handle the anticipated load. Any one of the three will be sufficient to handle emergency return power requirements, he said, while storage batteries in the Apollo service module will be adequate only for re-entry from earth orbit if all three fuel cells should fail.

Fuel cells will use potassium hydroxide liquid electrolyte and dual-porosity, sintered-nickel electrodes. Three solid-state inverters will convert part of the fuel cell output to 115/200 v., 400 cps. power.

Water generated by the fuel cells is a by-product will be used for the crew drinking supply. Its potability is now being tested on mice and it appears to be satisfactory.

Four different types of radiation detection devices presently are under study for use in warning astronauts of pending solar storm and dangers from high energy protons.

Two of these sensors, one operating at radio frequencies and the other in the ultraviolet region, require sun-oriented antennas of considerable weight. The other two sensors, a proton flux counter and a solid-state ion chamber, are lighter and smaller in size.

Proton flux counter is expected to give 10-15 min. advance warning of the arrival of solar radiation. This will provide time for the astronauts on the moon or in orbit to turn the spacecraft around for maximum shielding.

Cosmos Satellites Will Map Atmosphere

Moscow—Russia's Cosmos satellite series is planned to map the atmospheric layer between 200 km. (124 mi.) and 1,600 km. (995 mi.), as well as to provide specific data for space flights and spacecraft design.

V. Alsentsev of the State Astronomical Institute, Moscow, said that two orbital inclination angles have been used: 49 deg. and 65 deg. to the plane of the earth's equatorial plane. In the 49-deg. orbit the apogee moves in the same direction as the satellite above the surface of the earth; in the 65-deg. case the apogee moves in the opposite direction. By selective use of orbital parameters, the Cosmos series will intersect the entire 1,400-km. layer between the two limit altitudes.

Alsentsev added that Cosmos satellites supplied current space weather data before and during the Nikolayev-Popovich flight and were used to study micrometeoroid impact on spacecraft.

Mitsubishi MU-2 Business Plane Detailed

Tokyo—First deliveries of the seven-passenger, high-wing, twin-turboprop MU-2 business aircraft, designed by Mitsubishi Heavy Industries, Reorganized, Ltd (AW Mar 11, p 297), are scheduled for early 1965. Approximate basic price will be $208,000 or about $250,000 with avionics equipment. First flight will be this summer.

Cruising speed of the MU-2 will be 325 mph at 19,600 ft and range will be 1,100 mi. with standard fuel and a 30-min reserve. Range with two 50-gal. tip tanks will be 1,760 mi. with reserves, company says.

Aircraft will utilize high-lift device on the wing to vector the propeller slipstream and reduce landing and takeoff distances to 985 ft over a 50-ft obstacle. MU-2 will have full span flaps.

Engines are French Turbomeca Astazou 2K turboprops of 562 hp each. Internal power supply for engine starting will be included. Engines are located in pylon-mounted underwing pods and swing three-bladed, constant speed Ratier Figeac propellers. Canadian P&W PT 6s may be optional.

Mitsubishi says the aircraft is intended primarily for export, since the market for aircraft of this size in Japan is limited. For this reason, the MU-2 will be equipped with foreign-made subsystems, probably including AiResearch pressurization and air conditioning equipment, Goodyear wheels and brakes and Collins avionics equipment. There will be no hydraulic system. Landing gear and flaps will be electrically retracted. Minneapolis-Honeywell autopilot will be installed.

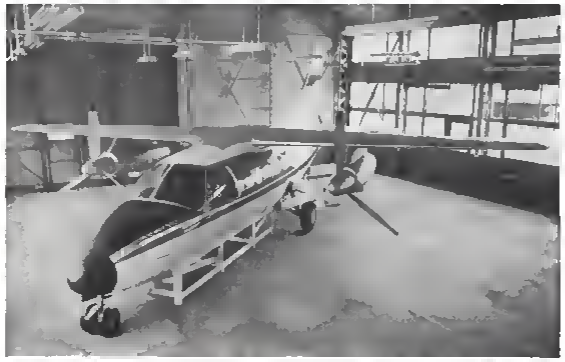
Four MU-2 prototypes are under construction at the Nagoya Aircraft Works of Mitsubishi. Two will be flight test vehicles and two will be used for static test. Company says development will cost about $1.4 million.

Certification both in Japan and the United States will be completed in time for initial scheduled 1965 deliveries.

Company says the aircraft is designed for ease of maintenance. Engines of the aircraft are located at eye-level when it is resting on the ground. Equipment associated with each subsystem will be located at one place in the MU-2. High wing passes over the circular fuselage to ease pressurization.

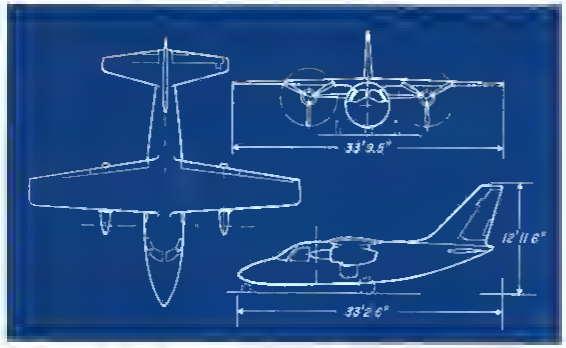
Mitsubishi has applied for patents on the high-lift device which will be incorporated into the aircraft. Low-pressure tires will be used to enable the MU-2 to operate from unpaved areas.

Automatic cabin temperature control will be installed and the aircraft will have anti-icing and defrost systems. Provision will be made for nose-mounted weather radar.



MU-2 MOCKUP has swept tail, pylon mounted engines, high wing. Gross weight with tip tanks is 7,540 lb. and useful load is 2,970 lb. Wingspan is 33 ft. 9.5 in.

EXECUTIVE INTERIOR will be offered. Aircraft has a service ceiling of 35,000 ft. and an empty weight of 4,570 lb. Height to tip of fin is 12 ft. 11.6 in.



THREE-VIEW OF THE MU-2 shows general configuration. Fuselage length is 33 ft. 2.6 in. Wing passes over circular fuselage to ease pressurization problems.

Bids Asked for Saturn 5 Launch Towers

Cape Canaveral, Fla.—National Aeronautics and Space Administration's Launch Operations Center here has invited 75 firms to bid on three launcher-umbilical towers—the mobile platform on which the Saturn 5/Apollo will be assembled and from which it will be launched. Proposals are due May 10 and an award is expected to be made later in the month, with completion of the three units specified within 18 months of contract signature.

Platform of the launcher-umbilical tower (LUT) will be 160 ft. long x 135 ft. wide and will have a depth of 25 ft. Four arms, each 11 ft. long with a 9 x 6 ft. base, will protrude from the top deck of the two-level structure to support the Saturn 5 during assembly and to restrain the vehicle at the time of launch, until full thrust develops in the first stage. Launch and checkout equipment will be housed in the lower levels of the platform.

Umbilical tower will be 380 ft. tall with 60 x 112 ft. base and a 40 sq. ft. superstructure above the 80 ft. mark. Hammerhead crane, with a 12 to 25-ton capacity and a hook height of 376 ft., will be mounted atop the tower.

Each LUT will weigh 10.5 million lb. Clearance between the bottom of the platform and the ground will be about 21 ft., whether the unit is resting on pedestals in the assembly building, on the launch stand or on the crawler transporter.

Platform will be moved from the Vertical Assembly Building to the launch area by a tracked crawler transporter, now under development by the Marion Power and Shovel Co., of Marion, Ohio. (AW Feb 18, p. 37)

McNamara Says No Deal Involved In Removal of Missiles From Cuba

Washington—Defense Secretary Robert S. McNamara told Congress "there were absolutely no undisclosed agreements associated with the withdrawal of Soviet missiles from Cuba" and that Chairman Nikita Khrushchev removed them for fear of inciting a nuclear war.

Rep. Jamie L. Whitten (D-Miss.) told McNamara during House defense appropriations subcommittee hearings which were released last week that "it is sort of unrealistic with Khrushchev's buildup that he suddenly would take his turn unless there was something which he expected." Rep. Whitten said "the American people are greatly disturbed" that there might have been some kind of agreement which led to the removal of the missiles. McNamara replied:

"If that is so, Mr. Whitten, the American people completely failed to understand what happened during that very important period of October. They failed to understand that we had a force of several hundred thousand men ready to invade Cuba. They failed to understand that had we invaded Cuba, we would have been confronted with the Soviets, that had we been confronted with the Soviets we would have killed thousands of them, that had we killed thousands of them the Soviets would probably have had to respond, that they might have had nuclear delivery weapons [that] might have been operational and they might have been launched, and that in any event Khrushchev knew without any question whatsoever that he faced the full military power of the United States, including its nuclear weapons. That may be difficult to understand for some, but it is not difficult for me to understand, because we faced that night the possibility of launching nuclear weapons and Khrushchev knew it, and that is the reason, and the only reason why he withdrew those weapons."

McNamara said he felt the American people did understand that this was Khrushchev's reason for removing the missiles.

Johnson, Webb Urge Space Plan Support

Washington—Vice President Lyndon B. Johnson and U.S. space agency Administrator James E. Webb have urged scientists and businessmen on the grass-roots and national level to support the U.S. space program.

At the Goddard Memorial Dinner here Mar. 22, Vice President Johnson said the "technological community which understands the stakes of space has a responsibility ... for helping the public understand those stakes. Unless and until this is done the technological community cannot justifiably be impatient with those who are chosen to represent and express the public's own will."

The Vice President referred to several instances in which members of the House space committee have suggested that the National Aeronautics and Space Administration's $5.7-billion budget be cut as much as 10%.

Webb met with a group of Massachusetts and industry leaders last week and urged their support for NASA's proposed Electronics Research Center in the Boston area and for the entire space program.

NASA officials said the Johnson speech and Webb meeting with the Massachusetts delegation did not indicate the beginning of a concerted campaign to build public support. Top NASA administration feels that it has enough congressional support to fend off a deep budget cut, they said.

BS.100 Selected For Hawker P.1154

London—Bristol Siddeley Engines last week was selected to supply its BS.100 vectored thrust engine for the Hawker P.1154 supersonic VTOL strike fighter, winning out over a proposal involving vectored thrust Speys submitted by Rolls Royce.

However, Julian Amery, minister of aviation, said he has asked Rolls and Bristol Siddeley to discuss the work that Rolls could do on subcontract. The P.1154 is the follow-on to the Hawker P.1127 strike fighter, and the BS.100 is a 38,000-lb. thrust development of the 1127's BS.53 Pegasus engine, featuring plenum chamber burning in the two forward nozzles.

Amery said the P.1154 concept had from the beginning envisioned the use of the BS.100, although Rolls "at a very late stage" had submitted its Spey design. The P.1154 will replace the Hawker Hunter and de Havilland Sea Vixen for the Royal Air Force and Royal Navy.

Selection of the BS.100 probably greatly strengthens Bristol Siddeley's position on supplying the powerplant for the Whitworth Gloster 681 VTOL transport for the RAF (AW Mar. 25, p. 39).

Rolls has been expected to propose its Speys for this airplane.

Project Hades

USAF Aeronautical Systems Div.'s Project Hades (hypersonic air data entry system) will evaluate orbit re-entry data of a ballistic shape which will simulate both ballistic and lifting vehicle characteristics. First launch in the program series has been scheduled for December, 1964.

Litton is prime systems manager and will build the air data computer and inertial guidance for the ballistic configuration. Subcontractors and their areas of responsibility include Lear-Siegler for ground display, Minneapolis-Honeywell for autopilot, American Gyro for attitude reference and control system, Aerolab Development Co. for interstage hardware, and Kidde for nose-reaction jets.

X-20 Contract for $358 Million Does Not Assure Glider's Future

Washington—Formal award last week of a $358 million contract to the Boeing Co. for the USAF X-20 (Dyna Soat) boost glider was a procedural step which still leaves the fate of that and other manned military space programs very much in doubt because of the attitude of Defense Secretary Robert S. McNamara.

Both of Washington's Democratic senators, Henry M. Jackson and Warren G. Magnuson cautioned that the contract does not represent a Defense Dept. commitment to continue the X-20 program. They along with USAF Gen. Bernard A. Schriever, commander of the Air Force Systems Command, have been trying to persuade McNamara that X-20 has considerable military value and should be continued.

But McNamara feels USAF participation in the National Aeronautics and Space Administration's Gemini program may be a substitute for X-20 and has ordered a six-month study of the two space projects (AW Mar. 25, p. 22). McNamara expressed his philosophy about X-20 specifically and manned military space programs generally in testimony released last week before the House defense appropriations subcommittee. He said USAF participation in the Gemini program will enable the Air Force "to participate fully in the manned earth orbit experimental and development work," McNamara also said:

"At the present time, it appears to me that the Gemini is advanced beyond the Dyna-Soar in technique and technology and potential. There is no clear requirement in my mind at the present time for manned military operations in space. Hence, I am not at all certain that we would ever wish to deploy a Gemini-type system, or for that matter, a Dyna-Soar type system. But were we to require manned military operations in low earth orbit, it appears to me that the Gemini approach is a far more practical approach, an approach that can be achieved far more quickly than the Dyna-Soar approach.

"While the Dyna-Soar offers certain advantages not present in the Gemini, specifically a greater control over the landing point, the two programs are so complicated. Gemini is so much further advanced than the Dyna-Soar I question whether we should continue both at their present rate. Therefore, I have asked the Air Force to consider the possibility of cutting back the Dyna-Soar and proceeding with the Gemini, and thereby saving substantial funds."

McNamara said the USAF Martin Titan 3 will not necessarily be canceled if X-20 is abandoned, because the booster is proposed as a building block in our launch vehicle capacity. "We hope it will become the standard launch vehicle for near-earth orbit weights between roughly 6,000 lb. and 25,000 lb. Whether Titan 3 proceeds to final development will depend in large part on the extent to which it can be developed to meet these objectives because there is an alternative to Titan 3, specifically the Saturn C-1."

He said Titan 3 is being restudied to determine whether it will, as previously assumed, be significantly cheaper to build than the Saturn C-1. However, if the new studies do not bear out these assumptions, McNamara said, "we must reexamine the desirability of Titan 3 vs. Saturn C-1." He said the X-20 accounts for only about 10% of the Titan 3 minimum requirements (AW Feb. 25, p. 26).

One unknown, McNamara said, is whether the sharp differences in the lift-to-drag ratios of the vehicles dictate continuation of X-20. X-20, McNamara said, has a lift-to-drag ratio of 1.5 while Gemini is about 0.25.

Air Force estimates the X-20 program will cost a total of $843 million, McNamara said. As of February, $340 million had been spent.

Cobra for Italy

Munich—Italian army is adopting West Germany's Bölkow Cobra wire-guided missile as its standard medium-range weapon for anti-tank defense.

Following an operational evaluation of several anti-tank missiles, including France's Nord SS.11, the Italian defense ministry has signed a licensed production agreement with Bölkow Entwicklungen for local manufacture of the Cobra.

Units will be produced in Italy by Sigme (Societa Generale Missilistica Italiana), a consortium composed of Fiat, Finmeccanica and Bombrini Parodi Delfino. Cobra also has been adopted by the Danish armed forces.

U.S.-USSR Space Plan Covers Direct Exchange of Weather Data

Washington—U.S.-Soviet Union agreement on cooperative space projects covers exchange of operational weather data transmitted directly between the two countries, common use and exchange of information on experiments conducted with the Echo 2 passive satellite and later discussions on joint magnetic field experiments (AW Mar. 25, p. 21).

Dr. Hugh L. Dryden, deputy administrator of the National Aeronautics and Space Administration and head of the U.S. delegation that met with the Soviet space officials explained in detail last week the agreement reached in Rome on Mar. 20.

Dryden said both sides have 60 days from Mar. 20 to review the agreement and suggest changes. He said preliminary agreement makes these provisions:

- **Launch of weather satellites** by both countries at intervals and orbits that will provide continuous coverage of most of the earth. Soviet scientists indicated they have tested cloud cover photography equipment and weather sensors in Cosmos satellite flights and expect to be ready to launch a weather satellite in 1964.
- **Transmission of selected cloud cover** pictures backed up by annotated photos, cloud analyses and other weather data between the Weather Forecasting Institute in Moscow and the Weather Satellite Center at Suitland, Md.
- **Transmission of telegraph,** facsimile, voice carrier and single frequency modulation signals between the U.S. and Russia via the Echo 2 satellite scheduled for launch this spring. Since the satellite will not be visible simultaneously from both countries, the receiving point in Europe will be Jodrell Bank Observatory at the University of Manchester in England. The receiving point in Russia is to be Zvenigorod Observatory at Gorki State University.
- **Resumption in May at Geneva** of discussions on cooperative magnetic field experiments using satellite-borne sensors.
- **Exchange of information** between U.S. scientists whose experiments flew on the Mariner 2 Venus probe and Soviet scientists who have experiments on that nation's Mars 1 spacecraft. This would occur during the COSPAR (committee on space research) meeting this June in Warsaw.

Dryden said the 24-hr. communications link for transmitting weather data will be a hard-wire link by cable and hard line or microwave. "The line is to be a four-wire link which would permit two-way facsimile transmission plus two-way voice or teletype transmission. It is to be set up early next year.

Military Space Requests Were Cut $607 Million to Avoid Duplication

Washington—Military services requested $2.3 billion for space projects in Fiscal 1964 but Defense Secretary Robert S. McNamara slashed off $606.6 million, partly because he feels there is a "real danger" the U.S. may finance duplicating national space programs.

His action was disclosed in hearings released last week by the House appropriations defense subcommittee which expressed considerable concern over whether the military had a large enough role in the national space program.

Specifically, the military services requested $2,274,600,000 for military space projects in Fiscal 1964 and McNamara reduced the total to $1,668,000,000. Among the proposals canceled were Blue Gemini and manned orbital development station (MODS) which together would cost $177 million in Fiscal 1964, he said.

McNamara said there is a real danger that the Defense Dept. and the National Aeronautics and Space Administration will sponsor duplicating programs in the field of manned space operations. He said he originated the joint USAF-NASA Gemini agreement to avoid this duplication. Gemini takes on added policy significance because it may well set the pattern for future military-civilian space projects.

Rep. Albert Thomas (D-Tex.), chairman of the appropriations subcommittee which handles the NASA budget, and one who pressed for placing the NASA Manned Spacecraft Center in Houston, assailed the NASA-Defense Dept. Gemini agreement as an Air Force attempt to invade the civilian space program.

McNamara said the joint participation may eliminate the need for the X-20 (Dyna-Soar) boost glider project and thus save about $500 million (see p. 36). He told Rep. Thomas that "unless there is a means of uniting these two agencies [USAF and NASA] in participation in a single project, then will be two projects.

"There is no clear requirement for military purposes for manned operations in space as we look at the future today," McNamara said in detailing his military space philosophy to the subcommittee. "And I draw a clear distinction between manned military operations in space on the one hand and unmanned military operations in space on the other.

"Secondly, however, whether there will be a military requirement in the future for manned operations in space I don't know. But should one develop it could come on suddenly in a field in which the lead time for the development technology is so long that I believe we must anticipate that possibilities today by entering out certain of the development work associated with putting a man in space for military purposes.

"That is one of the reasons we are pursuing Titan 3 to give us a capability for sending loads between roughly 6,000 lb. and 25,000 lb. into space. It is one of the reasons I am interested in Dyna-Soar and a Gemini project which will give the Defense Dept. experience in maneuverable reentry technologies and techniques providing for existence of human beings in orbit for an extended period of time.

"Secondly, with respect to the threat of manned operations in space, in as a matter of fact the threat of weapons being placed in near earth orbit, I don't believe it is very great. I may prove to be in error however, and we should therefore be prepared to deal with that threat should it develop," he said.

As for the requirement for a manned military operation in space, it is not clear to me what we gain by putting a man in space for military purposes. I do not see the future clearly. It may be that certain of our requirements in space cannot be met without a man there. It may be that in order to inspect properly unidentified satellites we might have to have a man in a U.S. satellite in space. I think it is rather unlikely we would require a man for those purposes in part because a man greatly complicates the operation in space. You have to put so much in space just to allow a man to exist that it greatly adds to the complexity of the operation.

But as our knowledge of space operations advances this conclusion may prove false and I believe therefore we should have boosters with a sufficient capability to put into space satellites that will allow men to operate within them," he said.

Asked about the need for developing satellites capable of launching nuclear weapons, McNamara said: "We see no clear military requirement for that. In case we believe that the accuracy would be reduced and the possibility and general control over the use of weapons particularly in terms of reaction time, would be less than we obtain from launching them from the surface of the earth. We recognize the possibility that some such requirements might develop in the future and we are prepared to meet them if they should."

He said he did not believe the Soviets were living in school if that capability but said "it always possible" so the U.S. was taking steps to make sure it could destroy any such Soviet weapon carrying satellites (AW Mar. 18, p. 24).

AADS-70 Proposals

Industry proposals for a technical evaluation study for Army air defense system for 1970 (AADS-70) are to be submitted to Army Missile Command by Apr. 22.

Contractors which probably will submit bids in the competition include Chrysler, General Dynamics/Pomona, Martin-Orlando, Ford Aeronutronic Div., General Electric, McDonnell, North American Aviation-Columbus, Northrop's Norair Div. and a team consisting of Douglas (missile), Hughes (avionics) and FMC Corp. (launcher and ground equipment).

News Digest

McDonnell Aircraft has been selected by General Dynamics/Ft. Worth as subcontractor to develop the cockpit ejection capsule for the TFX (F-111) aircraft. Both crewmen in the plane would be ejected in the single capsule. Propulsion contractors bidding for the solid propellant motor which would separate the capsule from the aircraft include Thiokol, Lockheed Propulsion and Rocket Power, Inc.

Hunting H.126 jet flap research aircraft (AW Sept. 3, p. 21) made its first flight Mar. 26 from the Royal Aircraft Establishment field at Bedford, Eng.

British European Airways negotiating for purchase of two Sikorsky S-61 twin turbine helicopters to replace de Havilland Rapide biplanes still used between Lands End and the Scilly Isles. Sikorsky was selected over Boeing Vertol apparently because of availability.

Lockheed Missiles & Space Co. will conduct research and development on the new long-range Polaris B3 fleet ballistic missile (AW May 11, p. 145) under a $160,353,807 BuWeps contract.

Air Force has reopened its SOR 190 support helicopter competition and a new request for proposals is due Apr. 1. Proposals are due May 1 and a decision is due before the end of May.

Army Martin Pershing solid-propellant field ballistic missile will undergo a series of rough terrain tests at the company's Orlando, Fla., plant and at Cape Canaveral before launching. First such exercise is tentatively scheduled for this week.

Agencies Divided on Foreign Aviation Aid

Congress may settle issue; FAA claims AID allotted only $10.6 million for air assistance in Fiscal '62.

By Robert H. Cook

Washington—Feud between the Federal Aviation Agency and the Agency for International Development over how much foreign aid money should be channeled into aviation development may reach a long-delayed climax this year during congressional appropriations hearings.

FAA feels that AID has misunderstood and underplayed the value of aviation in the overall foreign policy. This is best reflected in AID's Fiscal 1962 expenditures, totaling more than $1.8 billion, of which only $10.6 million was allotted to aviation projects throughout the world, FAA contends.

AID argues that it has budget limitations and many demands on its money, so that projects must be taken on a priority basis. It also points out that, unlike FAA, it can not afford to concentrate upon an one item of foreign aid, but must remain flexible in response to the most pressing economic and political needs of each individual country.

Armed with copies of the recent Clay Report, which recommends a gradual withdrawal and tightening of foreign aid participation, Congress may be forced to reappraise just how important a role aviation should play in U.S. foreign policy for underdeveloped countries.

On one hand, too severe a cut in AID's proposed $4.9-billion budget, without first examining the agency's workings, might spell a speedy end to the aviation phase of foreign aid. On the other hand, close congressional scrutiny of the issue might result in a shifting of priorities within AID and a greater emphasis on aviation.

In either event, the debate will be argued against the background of a White House international air transport policy study, advice from the Budget Bureau and President John F. Kennedy's deep immersion in the Alliance for Progress program for Central and Latin America.

The latter program alone conceivably could swing the tide in favor of aviation aid, many observers feel, since its possible application to aviation was a subject for lively discussion at a recent meeting of aviation representatives to the Organization of American States. Last year South and Central America received only $14 million in direct aviation grants from AID, plus a Development Loan Fund loan of $12 million. The previous year this type of aid totaled $13 million.

Project Horizon, an FAA study upon which much of the White House international air transport policy was formulated, pointed out that in addition to the U.S., other Western allies and Soviet Russia are interested in satisfying the aviation needs of foreign countries. Aviation support under the present AID program has been too closely concentrated upon international air transport and not enough on the internal aviation development necessary for self reliance and economic growth in many countries, the report stated. What is needed is a hard core of aviation experts in AID, reporting to the director and responsible for planning and designing U.S. aviation assistance projects, the report said.

AID is still in the process of reorganization after it was created two years ago from the old International Cooperation Administration, under which it had an aviation policy staff. In its present form, there is no such central authority and aviation is categorized in the field of transportation under four separate internal area divisions. Much of the decreased emphasis on aviation assistance in AID came about because there has been no one available to champion the cause, in contrast to AID's well qualified experts in such fields as sanitation, highway and building construction or maritime development.

FAA presently serves as a technical agent for AID, but has no particular voice in the projects approved. Last year it procured aviation facilities worth $3.7 million for installation in 26 countries, and provided resident technical assistance to 34 countries. It also acted as technical agent for the installation of $2.9 million in radar, instrument landing systems and communications equipment for the strategically important Ankara-Teheran-Karachi airway. The project was financed by AID under agreement with the Central Treaty Organization and the Southeast Asia Treaty Organization. FAA costs on all AID projects are billed annually to AID.

FAA Administrator N. E. Halaby has conducted a quiet campaign to place a greater emphasis on aviation assistance abroad, not only in the Horizon Report, but in his role as chairman of the Interagency Group on International Aviation (IGIA). This group provides the secretary of state with coordinated recommendations on international aviation problems. It is Halaby's influence that has been credited with a State Dept. decision to place more civil air attaches on American embassy staffs in key foreign capitals.

One of Halaby's latest moves to improve FAA's international efficiency is the creation of an assistant administrator post for assignment in Paris. About 15 people, most of whom will be transferred from other FAA stations, will staff the new headquarters, which will have full responsibility for FAA operations in Europe, the Middle East and Africa. Purpose of the new position and staff will be to strengthen FAA's air flight inspection services and provide the agency with timely data on research and development projects in Britain, France and Germany.

AID officials acknowledge that the agency is often subjected to pressure to parcel out more assistance to aviation and say the job is further complicated by military demands for AID money to offset Russian influence. Constant determinations must be made whether the project is necessary for economic development of the country making the request or whether it is a matter of politics or prestige.

At this time, AID feels that its aviation assistance program has reached a peak and should level off and drop in the next few years.

A high percentage of the assistance has gone for the building or improvement of international airports but the agency is expressing interest in going ahead with more but less costly, assistance for the development of internal aviation facilities.

Future assistance probably will be concentrated on continuing present training and installation of navigational aid facilities. There is also an indication that increasing numbers of small foreign carriers will seek AID backing for management and training by U.S. contract airlines.

AID aviation projects now in effect and under consideration, are funded on a regional basis in this manner:

• **Near East.** This region spent $33 million in direct grants in Fiscal 1962. Pakistan is installing navigation aids financed by a $2-million loan, and the country recently received a $4.3 million loan for a new airport at Dacca, capital of East Pakistan. Pakistan International Airlines has completed a training contract with Pan American World Airways, financed through AID.

A $14-million international airport has been completed at Kandahar, Afghanistan and the government has signed an AID contract for management of Ariana Airlines by Pan American. Ariana is also getting a DC-6 and two Convair 340s under a separate loan. Government of Nepal was given a fleet of 3 DC-3s under a direct grant and is now negotiating for management by a U.S. carrier. Syria is planning a new international airport at Damascus. It will finance construction of the project and is receiving free advice from FAA but will probably request loan funds for airport traffic and communications facilities. Largest expense during the year was the CENTO navigation system at a grant cost of $1.5 million.

• **Africa.** Total of $197,000 was distributed through Fiscal 1962 to Ethiopia, Liberia, Mali and Tunisia. The bulk of this—$139,000—was alloted to Ethiopia for operation of Ethiopian Airlines and facilities for a new airport at Addis Ababa and two other points. Ethiopia is presently using a $23-million loan granted in Fiscal 1961 and may get further aid for development of interior airfields. Roberts Field in Liberia is being improved, but may require further assistance for runway extension and additional navigation aids. Projects being considered also include possible AID assistance to Sudan for airport expansions at Khartoum and Port Sudan, plus similar projects in Tunisia and Morocco.

• **Latin America.** AID assistance last year totaled $14 million in grants to 13 countries and $12 million in Development Loan Fund money. The problem in this area has been to prevent an overlapping and duplication of projects for military and civil aviation in the same country. Brazil, with $321,000, and Argentina, with $203,000, were the largest AID clients. A group of six FAA specialists working on AID projects in Brazil will be withdrawn by June as a result of a $1 billion cut in AID's Fiscal 1963 budget.

Largest single project has been the improvement of El Centro Airport in Bolivia at a loan cost of $1.2 million. Bolivian government is also interested in obtaining a U.S. management team to operate its flag carrier, Lloyd Aereo Boliviano. A new regional AID aviation office with five specialists is being established for Central America and Panama at Guatemala City, Guatemala. Emphasis in this area has been on air traffic control training and maintenance of navigation aids, plus the formation of various aviation regulatory bodies.

• **Far East.** Eight projects were in force in this area last year at a grant cost of $2.1 million. Cooperation in the SEATO program by the Near East-South Asia Region of AID accounted for $751,000. Airport construction and improvement claimed nearly all of the remainder. Indonesia, Laos, Vietnam and Thailand were the major grant recipients. Improvements were made to Jakarta International Airport, navigational aids were installed there and elsewhere, and a maintenance contract for Garuda Airways was extended with Lockheed Aircraft Co. at a total overall cost for the year of $322,000. Laos had a similar program, including the rebuilding and improvement of its major airport at Vientiane. AID aviation assistance in Vietnam was largely concentrated on improving the major airport at Saigon plus the construction of several air strips in the back country. AID cost for the year amounted to $326,000. Thailand collected $160,000 in annual AID grants for improvements to Bangkok International Airport and 15 other smaller airports.

TWA Plans to Replace Holliday

New York—Raymond M. Holliday, Hughes Tool Co.'s single representative on the Trans World Airlines board of directors, has not been renominated and is expected to be replaced at the board's annual meeting Apr. 25.

William E. Robinson, former president and chairman of the Coca Cola Co., has been nominated to replace Holliday. TWA officials said Holliday had not attended board meetings for months, apparently due to the litigation between TWA and Hughes Tool.

Holliday is also a member of the three-man trusteeship controlling Howard R. Hughes' 78.2% controlling stock interest in TWA. The airline reorganized its board in 1961 after Hughes placed his stock in 10-year trusteeship in exchange for a $160-million loan.

In the reshuffle all Hughes Tool appointees were removed from the board except Holliday, who was the tool company's choice to serve as a trustee of the stock.

Although Holliday can be removed from the TWA board, he will remain as Hughes Tool's trusteeship representative, since Hughes retains the right to appoint one member of the trusteeship body.

Another new member of the board will be James J. Kerley, the carrier's vice president-finance. Kerley will fill the vacancy created by the resignation of A. V. Leslie, TWA's former vice president-finance and treasurer, who is now with Douglas Aircraft Corp.

Although TWA had considered soliciting a stockholder vote Apr. 25 on the proposed merger with Pan American World Airways, it has been decided to withhold the vote pending a re-evaluation of the merger agreement.

TWA still feels it may get a favorable judgement in the litigation with Hughes (AW Feb. 12, p. 49), a development that would require modification of the merger proposal in light of TWA's improved financial position.

TWA's financial statement shows it lost $5,704,000, or 85 cents a share, in 1962. Net earnings of $6,795,000 in the last half of the year reversed the loss trend which otherwise would have been nearer the $14,745,000 deficit of 1961.

Documents Scramble Follows Bolivian Crash

Crash of a Lloyd Aereo Boliviano DC-6B May 15 into Tacora Volcano on the Bolivian-Peruvian border set off the kind of scramble by Cuban and U.S. officials for documents at the crash site that has occurred after other civil airline crashes in South America since Fidel Castro began sending agents to countries there.

Among the 40 persons killed in the crash were two Cubans traveling on diplomatic passports. U.S. officials a small group of U.S. Army Rangers, two USAF Kaman HH-43B Huskie helicopters transported in a C-124 various Cuban diplomatic personnel, Peruvians and Bolivians converged on the tiny village of Villa Industria, Bolivia, nominally to take part in rescue operations.

The HH-43s were deployed because of their capability to operate from the Villa Industria site at an elevation of about 15,000 ft.

Intelligence aspects of the operation became public knowledge last week when Chile expelled a Cuban embassy secretary, Alfredo Garcia Almeyda. He had attempted to impersonate a Chilean citizen to cross the Peruvian border and reach the crash site in the race for the documents. Fate of the documents pouch was not clear, but indications were that the Cubans did not succeed in finding it.

DC-8 Pool for Europe-South America

Geneva—KLM Royal Dutch Airlines, Venezuela's Viasa Venezolana Internacional de Aviacion and Iberia Air Lines of Spain will pool their Douglas DC-8 turbojet services this summer between Europe and South America.

Agreement is designed to cut present high operational costs which stem primarily from duplication of services and resultant overcapacity, according to KLM.

Beginning today, KLM will operate from Amsterdam on Thursdays and Fridays, Viasa from Paris and Rome on Mondays and Wednesdays, and Iberia from Madrid on Tuesdays, Thursdays and Saturdays. All seven flights will stop at Madrid and terminate in Lima after stops at Paramaribo, Caracas, Curacao and Bogota.

In addition, KLM plans to modernize the equipment on its present DC-6 service from Europe to Curacao and Paramaribo, Curacao and Miami, The Netherlands Antilles and New York during the peak summer season. KLM will substitute Convair 880M turbojets on charter from Viasa.

The 880s will operate over each of these routes on a twice weekly basis beginning May 1 as an adjunct to the DC-8 pool to Curacao and Paramaribo.

Combined DC-8 pool and 880M service will provide KLM with three trips a week at Curacao, Paramaribo, Curacao and Miami and four per week on The Netherlands Antilles-New York segment.

Vickers Studying VC.10 Tail Cone Extension as Drag Reduction Move

By Herbert J. Coleman

London—Vickers-Armstrongs is considering lengthening the tail cone of the Vickers VC.10 four-engine, aft-mounted jet transport as part of its drag reduction program (AW Mar. 25, p. 35).

G. F. H. Hemsley, Vickers chief engineer, said the company now is running wind tunnel tests before making a decision on extending the rear fuselage on production models. The four airplanes now flying have totaled about 400 hr., and major modifications to engine pods and leading-edge slats will be incorporated on the No. 5 airplane, due to roll out this month.

By tilting the pods 3 deg. up and modifying the slats for a slight step-up during flight, Hemsley said, Vickers hopes to reach design drag specifications.

Other modifications from that point on, approximately 5% over the original specifications, will give the VC.10 the London-Los Angeles nonstop capability desired by British Overseas Airways Corp., he added.

Aside from the addition of a beaver tail between the jet exhaust pipes, there will be no modifications to the actual engine pods or their support beams.

Engines will be tilted, and extended 11 in. out from fuselage, by adding an extension to the two transverse beams which run across the rear fuselage cone. Pods will not be moved from their present position. Hemsley said the transverse beam addition will handle design bending modes, which will remain the same, thus eliminating any need for nacelle changes.

After investigation of wing pressure plots, Hemsley said, the company decided to raise the leading-edge slats higher than the torque box. Before the modification, the slats were slightly stepped down in flight, interrupting the airflow, and the modification has permitted a significant reduction in drag.

Hemsley said designers "now see daylight" in the drag reduction program, primarily because of low drag readings obtained in various climb conditions.

Company still plans on obtaining its certificate of airworthiness by the end of the year, and deliveries to BOAC, Royal Air Force and British United Airways will not be affected, according to Vickers.

Hemsley said the airplane was nearly ready for certification tests, but he noted that the drag resulting in the modifications did not show up in the wind tunnel. He added:

"We can only put this down to changes in the Reynolds number and the deficiencies in wind tunnel changes in boundary layer and downwash in a twin podded configuration."

Severe tail buffeting during early flights was traced to nacelle flow problems. This was fixed by addition of the beaver tail fairing and a slight extension to the fuselage strut to solve flow problems in the gulf area. Before trying this, Vickers installed a series of what Hemsley called "swept steps," or a sort of glorified vortex generator," but this did not work.

Decision to rotate the nacelles 3 deg. upward followed measurement of shock waves on the underside of the fuselage strut. At present, Hemsley said, the pods carry a download comparable to those on the tail plane, for trimming the aircraft.

Modifications will add about 300 lb. to the airframe, according to E. E. Marshall, assistant chief engineer.

In discussing test results, E. B. Trubshaw, Vickers chief test pilot, said the aim is to take the VC.10 to Mach .94. To date, Vickers has reached Mach .92, but Trubshaw said the plane must be put in a nose-down attitude to maintain this speed.

Trubshaw said that at Mach .88 the pilot must use some nose down trim in level flight, and at reaching Mach .91, this changes to nose-up. He said that up to Mach .88, the VC.10 experienced no buffeting, but that at Mach .90 the pilot could feel the beginning of a compression effect. Pilots asked for a lightening of lateral controls at these speeds.

Trubshaw said the low-speed regimes are "the real feature of the airplane." The VC.10 has been landed weighing 14,000 lb. more than maximum gross landing weight at 120 kt. over the threshold.

In comparing low speeds with the Boeing 707 series, Capt. A. P. W. Cane, BOAC's special duties (technical) manager said that at VC.10 takeoff weight of 299,000 lb., V$_2$ speed would be 140 kt. The equivalent V$_2$ speed for a 707 at maximum takeoff weight, 10,000 lb. higher, would be 165 kt.

Meanwhile, development test program for the de Havilland Trident three-jet transport is on schedule, with no major modifications to the airframe foreseen, C. T. Wilkins, de Havilland director and chief designer, told AVIATION WEEK & SPACE TECHNOLOGY. The four airplanes now in the program have flown about 600 hr. The company has 17 aircraft on the production line.

MEA Stock Purchase

Air France purchare of 20% of stock in Middle East Airlines is being interpreted to some airline quarters as the first step toward the merger of MEA with Air Liban, second largest Lebanese carrier.

French airline owns a controlling 48.25% of Air Liban stock. Sheikh Najib Alamuddin, head of MEA, is a private exponent of a Pan Arabian airline consortium including, besides Air Liban, the carriers of such countries as Jordan and Kuwait. The entry of Air France, which could supply the required technical and equipment assistance, might be the initial move toward such a union, some observers believe.

British Overseas Airways Corp. divested its 20% interest in MEA three years ago when BOAC began shedding holdings in associated airlines that were unprofitable.

Pan American's Bid for Chosen Instrument Status—Part 2

Repeated Efforts For Legislation Blocked

By L. L. Doty

Washington—Determination of Pan American World Airways to attain chosen instrument status and supplement its international system with domestic routes has held firm despite consistent failures to achieve either objective through legislation it has sponsored.

The drive for legislation to support the airline's cause has accompanied its drive for merger as a means to its end (AW Mar. 25, p. 38). Stiff industry opposition to Pan American's merger tactics has never quashed its hopes of some day merging its international system into a chosen instrument operation.

On the other hand, rebuffs to its legislative moves have brought at least a temporary halt to its activities in this area, although Pan American's zeal is so intense that it would be unrealistic to predict it will never make another stab for the legislation it wants. Eagerness of Pan American President Juan Trippe for the chosen instrument and for domestic routes stems almost as much from emotion as it does from economic reasoning.

Trippe has always contended that there is not enough international traffic to accommodate two or more U.S. flag carriers. He later expanded this argument by claiming that the growing torrent of foreign flag competition on major international routes rendered competition between U.S. carriers unnecessary and nullified any charges of monopoly.

International Routes

In addition, he has consistently held that if domestic carriers are authorized to serve international routes, an international carrier should be granted the right to operate domestic routes; a contention he bases on the simple premise of reciprocity. Of the 11 U.S. domestic trunklines, eight have international routes of varying size, ranging from TWA's and Northwest's long-range routes to Northeast's Montreal-Boston route.

From its start in 1927 until 1940, Pan American held a monopoly on U.S. international routes under an unwritten U.S. policy that endorsed the chosen instrument concept. During that time, there were sporadic efforts to introduce competition on these routes, but it was always easily overcome by Pan American, primarily because the airline held a firm grip on air mail contracts.

The monopoly was lost in 1940, when American Export Airlines was given a temporary certificate to operate a transatlantic service. Simultaneously, government agencies that had previously backed the chosen instrument principle began to swing to the theory of competition. U.S. Navy for example, which had always worked closely with Pan American, reversed itself in 1939 from its historic support of Pan American as a chosen instrument to endorsement of a competitive international route structure.

World War 2 deferred close competition between Pan American and American Export but Pan American was prepared to combat the competition it anticipated in post-war airline operations.

First round of its fight for legislation authorizing a single-carrier operation in international air services came in May, 1944, when the airline sponsored the original chosen instrument bill in the Senate.

Provisions Listed

Stripped of details, the bill made these provisions:

- A corporation, entitled the All American Flag Line, would be created to operate as a carrier in foreign air transportation under the U.S. flag.
- Carrier would be entitled to subsidy, but would be capitalized by the issuance of $200 million in Class A stock and an unlimited amount of Class B stock. Class A stock would carry voting rights, Class B stock would not.
- Eligible subscribers to Class A stock would be U.S.-certificated air carriers only. Class B stock would be issued to cover payments for assets purchased by the chosen instrument carrier from holders of Class A stock.

Hearings on the bill were held in March, 1945, by the Senate Commerce Committee. Although Pan American obviously supported the plan, it did oppose certain facets of the flag carrier's corporate framework developed in the bill's final form. All domestic

Insurance Firm Probe May Stall Merger

Washington—Possibility that the Civil Aeronautics Board will launch an investigation into the role insurance companies have played in airline financing threatens to delay further the plans of Trans World Airlines and Pan American World Airways to merge.

Meanwhile, a Senate anti-trust subcommittee is preparing a staff study on the effect the proposed merger would have on domestic carriers. The question of airline control by financial institutions will also be studied. A House anti-trust subcommittee conducted a similar probe last year (AW Apr. 2, p. 26).

Metropolitan Life Insurance Co., Equitable Life Assurance Society and Pan American, backed by a number of other insurance firms, last week made a bid to sidetrack the investigation which Hughes Tool Co. had requested as a means of determining whether insurance companies control the airlines. Specifically, Hughes Tool has alleged that the two insurance companies together with Irving Trust Co. and others, have violated certain anti-trust provisions of the Federal Aviation Act of 1958 (AW Feb. 18, p. 49).

Replies filed with the CAB argued that the Board has no authority to conduct such an investigation and that the only purpose Hughes Tool had in making the request was to delay anti-trust suits that TWA and Hughes have brought against one another. In its reply, Pan American denied that it had conspired with Metropolitan Life to develop a merger agreement that would eliminate Hughes control of the merged airline.

If procedures in the case are started, the proposed merger would not only be stalled, but the entire U.S. airline industry would be subjected to a searching probe of its financial affairs.

As of late last week, the Board had not replied to the Hughes request for an investigation, although it had officially acknowledged its receipt. Meanwhile, hopes that the merger plan would move into Board procedural phases this spring continued to dwindle as the CAB remained adamant in its decision to defer it, and prospects that TWA's financial condition would show substantial improvement this year (AW Mar. 18, p. 45).

CAB interest in the question of insurance company control of airlines was first disclosed in Aviation Week & Space Technology (Feb. 5, 1962, p. 43).

Supplemental Airlines—1962 Statistics

1962 Operations and Traffic

Airline	Revenue Miles (000)	Revenue Passengers	Passenger Miles (000)	Passenger Load Factor (%)	Ton Miles (000) Revenue	Ton Miles (000) Available	Average Ton Load	Average Ton Capacity	Over-all Load Factor (%)
AAXICO	1 922 3	2 978	4 920	100	17,183 1	23 227 6	8 94	12 09	74
American Flyers	954 5	39 645	41,664	48	4 536 7	12 619 9	4 75	13 22	36
Capital	11,214 8	69 790	258,721	82	93,332 1	118 299 3	8 32	10 55	79
Johnson	119 2	2 146	712	56	41 8	176 9	0 69	1 48	46
Modern	325 7	17 776	18 379	70	1 575 1	2,612 0	5 78	8 02	72
Overseas National	8,244 9	96,386	249 280	82	26,245 7	37 923 0	8 39	11 49	69
Perdoo	238 7	7 866	4 171	74	415 4	869 3	1 74	2 30	62
Saturn	538 4	21,312	33 566	60	3,815 4	4 509 2	7 10	5 50	85
Southern	3,271 8	87,417	97 662	45	19 946 8	29,835 1	6 07	9 12	67
Standard	1 845 1	44 477	85,402	85	9,922 7	9,953 8	9 49	9 52	100
Trans-International	3 660 0	48 567	191 498	82	39,431 2	88,790 6	10 77	10 80	57
U S Overseas	2,214 2	81 639	164 847	77	14,481 7	21,847 2	6 63	9 87	67
Vance Roberts	14 7	962	294	75	25	25	1 76	1 76	100
World Airways	11,255 2	64 629	364,126	86	118 227 9	155,343 7	9 79	13 80	71
Zantop	6,904 9	0	0		31,515 4	55,489 4	4 56	8 03	57
Totals	46,917 6	584,790	1,514,442	73	373,138 2	541,321 0	7 95	11 54	69

1962 Revenues and Expenses

Airline	Operating Revenues: Transport: Individual Sales	Transport: Contract & Charter	Transport: Non-Transport	Transport: Total	Defense Contract: Amount	Defense Contract: % of Total	Total Operating Expense	Net Profit
AAXICO	a	2,692 7	(5 5)	2,697 2	2,692 7	100	2,609 9	88 2
American Flyers	127 a	2 060 9	20 9	2 208 8	1,633 3	74	1 859 6	341 8
Capital	947 5	17 459 3	149 3	18 775 1	14,911 7	79	18,284 4	57 1
Johnson	0	745 a	382 0	1 127 8	a	0	1,121 a	13 6
Modern	40 9	953 2	11 4	1 005 5	913 5	85	880 4	92 4
Overseas National	1,398 7	6,910 0	138 7	8 439 4	8,160 8	73	8,254 4	682 1
Perdoo	a	295 4	67 1	402 5	5 0	1	435 6	15 8
Saturn	11 9	1,371 6	33 8	1 417 3	787 9	85	1,388 8	18 2
Southern	374 0	5,151 0	208 0	5 733 9	4,924 8	86	5,414 7	169 6
Standard	1,619 4	1,023 1	170 1	2 812 6	983 9	32	2,714 a	68 3
Trans-International	19 6	10,024 8	2 4	10,047 8	10,057 2	100	8 638 9	1,379 5
U S Overseas	4,799 1	894 5	47 9	5,741 4	698 7	12	4,160 a	1194 1
Vance Roberts	6 8	16 9	1 4	24 3	0	a	32 9	(8 7)
World Airways	16 5	23 850 2	241 3	23,308 a	21,438 7	92	19,321 4	2,024 7
Zantop	8	7,850 4	8 5	7,858 9	4,469 8	56	6,700 5	486 3
Totals	9 352 6	80 788 a	1,499 a	81,650 5	89 424 a	70	83,793 5	5,034 8

Prepared By Roy & Roy

carriers, except United Air Lines, opposed the bill. Government agencies involved and labor unions also fought it.

It was never passed and three months later TWA was certificated as the third carrier on the North Atlantic.

Second Bill

In 1947, another chosen instrument bill was introduced in the Senate that called for the consolidation of international air carriers. Briefly, this bill authorized all international carriers to file with the Civil Aeronautics Board a proposed plan of merger. Any U.S. certificated scheduled airline with international routes was entitled to participate.

Both the Senate and House commerce committees conducted hearings in May and June of 1947, but the Senate group attracted most attention because of the aggressive support given the bill by its chairman, the late Sen. Owen Brewster (R-Me.). Trippe and W. A. Patterson, president of United, again stood alone as the sole industry supporters of the bill.

The bill was rejected by the committees of both houses of Congress after James M. Landis, the CAB chairman, and the late George Marshall, former secretary of state, violently attacked the chosen instrument principle.

These legislative failures buried the chosen instrument theory and, this year, the new White House policy on international air transportation (AW Feb. 11, p. 38) apparently removed any chance of it being exhumed during the Kennedy Administration. But the Trippe drive to attain this goal was to have wide repercussions that would damage the chosen instrument concept in the eyes of the nation.

In August, 1947, the Senate War Investigating Committee, headed by Brewster, began a probe of wartime contracts of Howard Hughes for the XF-11 photo aircraft and the HK-1 200-ton flying boat.

Hughes' Accusation

The hearings brought on a series of charges and countercharges, sparked by an accusation by Hughes that Brewster had used threats of an investigation into the contracts to force a Pan American-TWA merger and to get Hughes' support for the 1947 chosen instrument bill, sponsored by Brewster.

In his testimony, under oath,

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BAB 33

Tighter FAA Control of Aid Funds Sought

Washington—Federal Aviation Agency control over disbursement of airport aid funds may be tightened under Administration-suggested amendments to the Federal Aid to Airports Act scheduled for hearings Apr 9, 10 and 11 before the Senate aviation subcommittee

Legislation to extend the act for three years at a cost of $225 million will include three major amendments designed to give FAA control over a larger proportion of airport aid funds automatically allotted to states, plus their actual use

Present provisions of the act divide $75 million annually between the states on a population and geographic area formula, with 75% of this amount allotted directly to the state and 25% withheld at the discretion of the administrator

As proposed by the Administration, this formula would be changed to give the states only 50% of the allocation, with the balance held in a discretionary fund

A second amendment would reduce the buildup of unused allocations by states over successive years In the present form the act provides that funds allocated to any state, which remain unused within two fiscal years, will revert to the FAA discretionary fund. The change would reduce this holding time to only one year

Improved land use in airport areas and less aircraft noise problems are being sought in a third amendment which authorizes the administrator to reject the grant of any airport aid funds to individual communities unless adequate zoning laws have been enacted to make airport area land use compatible with expected operation of the airport

Hughes charged that Brewster had in so many words told me at luncheon in Brewster's suite in the Mayflower [hotel in Washington, D C.] that if I would merge TWA with Pan American World Airways and go along with the community company that there would be no further hearings in the investigation."

Palm Springs Meeting

With respect to the Palm Springs conferences in April of that year, Hughes said

"During the course of these discussions, I asked Trippe what he would do about Brewster He said he would talk to Brewster when he returned and get him to hold up the investigation and hearings on the community company bill until we could get together. Trippe talked about Brewster as though he [Brewster] worked for him [Trippe]."

Brewster denied the charges, but admitted he had accepted some hospitality from Pan American, including several free rides on a Pan American executive plane

The probe collapsed abruptly after two weeks of hearings Hughes had apparently been vindicated but serious damage had been done to Pan American's efforts to lobby for a chosen instrument bill

The chosen instrument concept arose again during the 1956 hearings on monopoly by the House anti-trust subcommittee, but gained little ground Trippe's attempts to soften the sting of monopoly implicit in the chosen instrument concept, by referring to a single carrier operation as a "community airline," failed to evoke much sympathy for the plan from the committee's chairman, Rep Emanuel Celler (D N Y),

When Trippe raised the community airline issue in his testimony, the subcommittee immediately became fascinated with the stock issues that would be involved

"If the so-called chosen instrument bill had been approved by the Congress, isn't it correct that Pan American stockholders would have held the largest amount of stock in this new company?" Trippe was asked

Trippe's answer to the question and a dozen subsequent ones apparently satisfied neither the subcommittee's counsel nor of its chairman. The subject was then dropped

About the closest that the chosen instrument theory has come to being revived since then came late in the Eisenhower Administration, when a report issued by United Research, Inc., for the White House recommended a single-carrier operation on low density routes (AW Dec. 10, 1960, p. 40)

Lenders' View

At the same time, the Aviation Security Committee of the Investment Bankers Assn of America noted that "if our international airlines are to meet their foreign competition successfully it may be that they should complement each other's services rather than drain themselves in internecine conflict."

But these small wisps of hope for Pan American came during the lame duck period of President Eisenhower's last term and they were shunted aside by a new Administration bent on eliminating monopoly wherever it proved practical

(This is the second of three articles on Pan American World Airways' bid to become the U S chosen instrument and annex domestic routes to its international system.)

Four Carriers Report Higher 1962 Earnings

Washington — Substantial improvements in net earnings for 1962 over the previous year were reported last week by Continental Air Lines, Mohawk Airlines, North Central Airlines and Seaboard World Airlines

In its annual report to the stockholders, Continental showed net earnings of $1 8 million, highest in the carrier's history and the fourth consecutive year that earnings have exceeded the $1 million mark At the end of the year, net worth of the company stood at an all-time high of $27 million, and net working capital of $10 1 million represented a 117% increase over year-end 1961

Operating revenues were $66 million for the year, compared with $62 9 million in 1961 Expenses were $61 2 million, contrasted with 1961's $58 million Airline's breakeven load factor was 42 2%, lowest in trunkline industry

Mohawk Airlines reported net earnings of $540,803 for the year a 64% increase over the 1961 profit of $329,749 Passenger revenues rose 28% to an all time high of $23 3 million Operating expenses climbed to $22 million, a 26% increase over the previous year

North Central Airlines reported a net profit of $534,333, compared with $353,114 reported in 1961 Revenues were $27 1 million a 7% increase over 1961, and operating expenses were $25 6 million a 5% increase over the previous year

Seaboard World reported its first profit since 1956 with a net income and special credit of $1 million equal to 29 cents a share The airline had a net loss and special credit of $3 7 million in 1961 Operating revenues rose to $23 2 million in 1962, an 11% increase over 1961

Airline Pilots Assist In Testing for SST

Washington — Federal Aviation Agency is using regular airline pilots in a flight test program to develop flight control and display concepts for supersonic transport aircraft

Program is being conducted jointly by FAA and the Flight Control Laboratory of the Air Force's Aeronautical Systems Div at Wright Patterson AFB The pilots made available by six major airlines, are performing up to 4 hr instrument flying daily in T 39s

The aircraft are equipped with experimental split-axis autopilots and "force wheel" control, which are used to provide, assist or override one or more axes of automatic aircraft control to investigate all regimes of control between fully automatic and fully manual

SHORTLINES

► Air Line Pilots Assn. President Charles Ruby, last week called for a full scale research and development program for aircraft instrumentation. Ruby charged that many instruments on jet aircraft are the same used by the airlines 20 years ago. He specifically criticized lack of precision of altimeters and erroneous readouts on airspeed indicators.

► Braniff Airways will introduce a new advance check in procedure throughout its system beginning next week. Boarding passes and baggage tags will be issued to passengers when they purchase their tickets. This will eliminate standing in line at airport counters for passengers who bought tickets in advance.

► British West Indian Airways will expand its U.S. sales effort by creating a new sales district covering seven central Atlantic states.

► Eastern Air Lines said that during the first two weeks of its New Orleans-Houston Walk-On service, traffic between the two cities was 77% higher than in the same period before the service started. In addition 40% of Eastern's passengers between the two points used the Walk-On service.

► Irish Airlines has purchased a Boeing 707-320 aircraft for delivery next year. It has not been decided whether it will be a 320B passenger model or a 320C with convertible passenger-cargo capability. Cost of $7 million will be covered by airline funds. The purchase was approved by the Irish government.

► Northwest Orient Airlines has launched a major Alaska sales promotion program with emphasis on commercial travel in the future and vacation travel during the coming tourist season.

► Russia's Aeroflot has adopted another travel promotion plan in an effort to maintain a satisfactory load factor in the face of soaring seat capacity. The Soviet carrier announced that until May 15, Red Army military and civilian personnel and their families authorized for rail transportation may fly instead, regardless of the difference in price.

► Timmins Aviation Ltd. of Montreal has been appointed by de Havilland Aircraft of Canada as the exclusive sales and service representative for the DH-125 executive jet aircraft.

► United Aircraft Corp. spent $3.8 million in 1962 for scheduled airline services. UAC personnel travel about 51 million passenger miles during the year on scheduled airlines.

AIRLINE OBSERVER

► Chances are strong that American Airlines will be the next carrier to experiment with the single-class fare (AW Feb. 18, p. 44). However, some industry officials are beginning to feel concern that the competitive value of this and other new promotional fares may be lost because of the confusion the wide variety of such tariffs has created among air travelers. Also in question is whether the experiments will really prove which fares are advantageous, as the Civil Aeronautics Board is not satisfied with the records airlines have maintained to back the new tariffs.

► Watch for a TWA order for three Boeing 707-320C aircraft convertible to either cargo or passenger use. Planes will be financed from the carrier's equipment budget, plus additional loans from financial institutions. TWA will use the aircraft for both transcontinental and transatlantic cargo service.

► Heavy short selling of National Airlines common stock is a technical trading situation rather than any indication of market sentiment. Professional traders, by watching the market closely, have been able to sell the stock short by purchasing National's 6% debentures, which are convertible into common stock at $15 per share. This puts them in a position to make money or limit losses no matter which direction the price moves. As of mid-March, 116,287 shares of National stock—selling in the $25 per share range—had been sold short out of a total issue of 1,861,560. Price of the debentures has climbed from a face value of $100 to $160-$165 as a result of the unusual situation.

► Growing space and missile industry in areas outside traditional industrial sections of the U.S. is drawing trunkline attention to possible changes in the basic airline route structure. An increasing number of airline officials feel that the route pattern will undergo substantial revisions during the next decade as airlines seek to penetrate new traffic markets—such as the southwest U.S.—now being created by the space industry.

► Trunkline and all-cargo carrier total cargo ton miles continued to rise during February, when a 10% increase over February 1962 was recorded. American Airlines, with 14.8 million cargo ton miles, led the industry during the month, and United was a close second with 13.6 million ton miles. TWA reported 7.7 million and Eastern 5 million. Flying Tiger Line operated 5.4 million ton miles in domestic operations.

► Airline industry was surprised at the Civil Aeronautics Board order dismissing its investigation of private airline club waiting rooms on grounds that the case would not serve the public interest. The order drew a sharp dissent from members Robert T. Murphy and G. Joseph Minetti, who argued that it is in the public interest to ensure against possible discriminatory practices that the clubs may create. In their joint dissent, they said that the clubs may cost the carriers almost a $1 million loss annually, which would raise the issue beyond that of "bare discrimination."

► De Havilland Aircraft is doubling DH-125 executive jet production line capacity to 60 airplanes on basis of new orders. Newest buyer is Baron H. H. Thyssen-Bornemisza, European industrialist. Three more orders will be announced this week, bringing total sales to 27 airplanes. Negotiations with Pan American for another 40 are still under way.

► Agency for International Development (AID) has loaned the Afghanistan government $2,625,000 for the purchase of one Douglas DC-6 and two Convair transports. An AID spokesman said the loan also covers spares, parts and flight crew training. Current price in used plane market for the DC-6 is about $750,000 and about $300,000 for the Convair 340 model. Loan is to be repaid in dollars in 40 years at 0.75% interest. Afghan government will relend the money to Afriana Afghan Airlines for repayment in Afghan currency in 10 years at 3½% interest.

► Aeroflot reports that 40%, or about 10.8 million of its 1962 total of 27 million passengers traveled on local routes ranging in length from 90 to 300 mi. The figure was cited by the Soviet press to stress the need for more small, short-haul aircraft.

Airline Traffic—January 1963

	Revenue Miles (000)	Originating Passengers (000)	Revenue Passenger Miles (000)	Revenue Passenger L/F (%)	Total Revenue Ton Miles (000)	Average Over-all Load (Tons)	Scheduled Miles (000)	Performance Factor (%)
DOMESTIC TRUNKS								
American	10,736	635	525,581	54	66,210	6 2	11,014	96 8
Braniff	2,602	200	95,799	52	10,870	4 2	2,668	96 3
Continental	2,219	128	90,218	47	9,892	4 5	2,247	97 9
Delta	4,971	358	234,565	58	26,301	5 3	5,310	92 0
Eastern	9,139	725	382,052	48	41,429	4 5	9,650	93 3
National	2,554	171	134,868	51	14,850	5 8	2,738	92 0
Northeast	1,739	120	70,249	52	7,310	4 2	2,008	84 6
Northwest	2,943	184	123,674	46	14,479	4 9	2 971	98 3
Trans-World	7,767	417	367,332	49	45,449	5 9	7,840	98 5
United	14,527	884	610,246	50	73,737	5 1	14,998	95 0
Western	2,082	186	104,317	51	12,140	5 8	2,150	96 6
Trunk Total	61 279	4,008	2,738,931	51	322,677	5 3	63,596	95 1
INTERNATIONAL								
American	173	12	12,593	69	1,556	9 0	184	100 0
Braniff	288	10	12,759	47	1,609	5 6	284	100 0
Caribair	167	52	4,079	55	420	2 5	157	98 2
Delta	101	2	3,900	45	481	4 8	101	100 0
Eastern	1,004	46	70,469	55	7,511	7 5	1,089	93 0
Mackey	65	7	1,112	30	118	1 8	64	99 3
Northwest	842	16	36,690	44	4,573	7 8	845	91 4
Panagra	333	11	18,321	58	2,691	8 1	326	100 0
Pan American	9,198	317	573,749	53	84,118	9 1	8 757	95 9
Sault Pacific	11	1	407	45	42	3 8	11	100 0
Trans-Caribbean	280	15	28,118	62	2,969	10 6	306	71 1
Trans-World	1,842	23	82,484	37	14,485	7 9	1,872	98 1
United	550	15	38,458	59	4,682	8 5	545	100 0
Western	189	8	12,516	69	1,388	7 3	189	100 0
International Total	15 043	535	895,655	51	128,640	8 6	14,698	95 7
LOCAL SERVICE								
Allegheny	893	75	15,603	38	1,658	1 9	975	91 3
Bonanza	515	42	11,041	56	1,091	2 1	516	99 0
Central	582	26	5,516	38	586	1 0	601	95 3
Frontier	940	37	10,497	36	1,119	1 2	978	95 6
Lake Central	540	37	5,988	38	632	1 2	582	90 8
Mohawk	898	87	17,628	46	1,830	2 0	976	90 1
North Central	1,238	89	15,535	39	1,667	1 3	1,229	99 0
Ozark	798	56	10,758	46	1,133	1 4	889	89 6
Pacific	466	41	8,900	45	881	1 9	485	94 8
Piedmont	879	57	12,864	38	1,342	1 5	931	93 6
Southern	699	37	6,758	33	724	1 0	840	82 2
Trans-Texas	663	34	8,195	40	865	1 3	694	93 5
West Coast	569	27	6,600	35	665	1 2	598	94 4
Local Service Total	9 680	645	135,893	41	14,203	1 5	10,294	92 9
ALASKA & HAWAIIAN								
Alaska Airlines	210	5	4,030	33	979	4 7	142	90 4
Alaska Coastal	86	6	472	55	40	0 7	91	68 2
Alaska	167	26	3,724	56	307	1 8	155	96 3
Cordova	81	2	270	52	40	0 5	29	79 6
Hawaiian	259	35	5,219	50	573	2 2	254	90 1
Kodiak	8	1	16	38	3	0 3	9	88 8
Ne Consolidated	104	2	482	33	146	1 4	102	90 0
Pacific Northern	312	10	8,790	31	1,522	4 9	347	84 0
Reeve Aleutian	68	1	769	29	207	3 1	87	66 9
Western Alaska	22	1	26	55	4	0 2	17	94 0
Wien Alaska	203	2	865	27	312	1 5	128	85 9
Alaska & Hawaiian Total	1 520	91	24,665	37	4,153	2 7	1,362	85 8
HELICOPTERS								
Chicago	25	4	82	32	8	0 3	29	85 9
Los Angeles	66	11	439	38	50	0 8	73	89 5
New York	36	16	321	37	33	0 9	50	67 9
Helicopter Total	127	31	842	37	81	0 7	152	81 8
CARGO & OTHERS								
CARGO & OTHER				Not Available				
Aeravias								
Avalon	27	6	343	55	33	1 2	9	94 4
Flying Tiger	995	1	7,393	87	12,680	12 7	502	92 1
Riddle	964	3	11,927	89	7,516	7 8	115	97 2
Seaboard	559	4	14,815	97	10,386	18 6	345	99 7
Slick	532	1	177	11	6,114	11 5	170	96 1
Cargo & Other Total	3,077	15	34,655	88	36,729	11 8	1,141	95 5
Industry Total	80,726	8,325	3,850,611	50	506,698	5 6	91,233	84 8

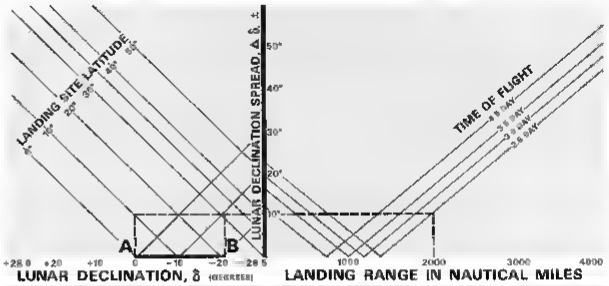
Prepared by Ray & Ray

Destination: EARTH

After a final, over-the-shoulder glance at the craggy lunar scene, moon explorers will apply themselves to the new task at hand—getting back home. How will the lunar declination at time of lift-off be interrelated with earth landing site latitude, time of flight and landing range from re-entry at $\gamma = -6°$ to touchdown?

Curves Provide Key

The curves at upper right provide the key. Window AB describes the range of lunar declinations, from +0.5° to −20.5°, acceptable for returning to an earth landing site at a latitude of +10°, for a 2.5 day time of flight with a landing range of 2000 n.mi. from re-entry at $\gamma = -6°$ to touchdown. The schematic illustration shows the trajectory plane for a lunar declination of −10°. As lunar declination varies through the acceptable range shown in the curves, the trajectory plane will rotate around the radius from earth center to landing site.



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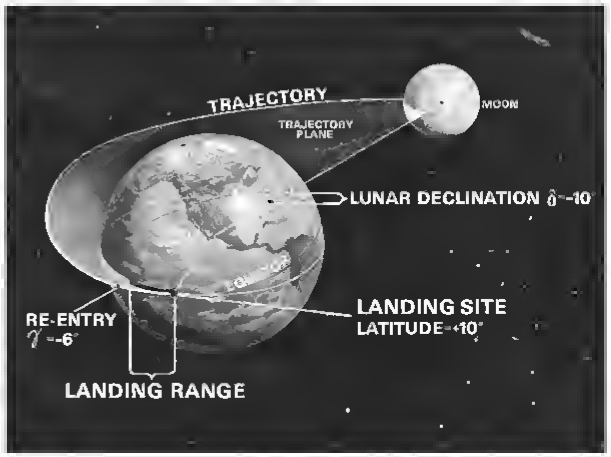
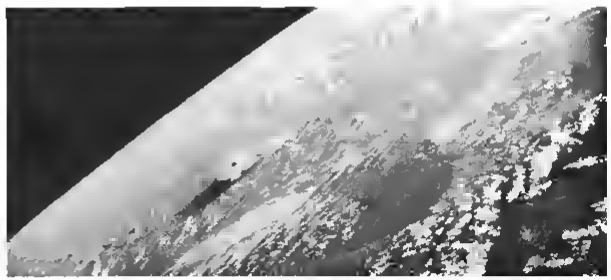
At Astronautics, we are deeply involved with a great variety of space-oriented activities. These include the design and development of boosters and vehicles to accomplish far ranging missions as well as the analysis of the paths they will follow. We're developing the precise electronic systems that will guide, track and communicate with the men and machines. Our efforts along many aerospace frontiers are creating a number of opportunities for engineers and scientists with exceptional abilities. If your interests and experience qualify you to fill one of these positions in advanced areas of activity, we urge your inquiry.



LUNAR LIFT OFF AT δ = −10° *Heading for an earth landing site latitude of +10°, a vehicle will describe this approximate trajectory over a 2.5 day time of flight. Landing range from γ = −6° to touchdown would cover some 2000 n.mi. in this case.*

Details for Engineers and Scientists

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics/Astronautics, 5819 Kearny Villa Road, San Diego 12, Calif.



RE-ENTRY MINUS 60 SECONDS *The earth will present this aspect to returning moon explorers as they near their destination. This photograph was taken at an altitude of 100 miles from a NASA Mercury capsule, boosted into orbit by an Atlas space launch vehicle.*

GD

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A MESSAGE OF INTEREST TO ENGINEERS AND SCIENTISTS

Important positions exist in the following areas:

DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas

STABILITY AND CONTROL to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non linear servo characteristics Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters

STRUCTURAL DYNAMICS to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence engine ignition, vehicle staging Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems —and for monitoring tests of complete or scaled dynamic models of space vehicles including layout of test plan, instrumentation requirements, scaling factors etc

ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, advanced tracking systems and payload programs Experience should include advanced design work in such electronic areas as guidance communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is desirable

STRESS ANALYSIS

Specialists are required to perform stress analyses on advanced missile and space vehicle designs and associated ground equipment The development of new analysis methods and test design for evaluation of structural adequacy are additional tasks in this area BS or MS degree and at least three years of appropriate experience are prerequisites for these positions

ELECTRICAL ENGINEERING

BS or MSEE with applicable experience required for assignments in launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing Openings exist in design, development vendor qualification selection, and test of ground and airborne missile electrical equipment

THERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics Particular considerations are re entry heating, heat dissipation in free space, and aerothermal heat sources Should have two years of experience

INERTIAL GUIDANCE

BS degree in physics, EE or ME and 2 to 5 years of experience in one or more of the following

TECHNICAL ANALYSIS scope includes establishment of guidance and flight control system requirements analysis of system performance, establishment of test parameters and initiation of design changes.

AUTOPILOT DESIGN assist in the detail design and development of the Centaur space vehicle flight control system The system includes the autopilot, programming devices, and passive tracking equipment The designer is also responsible for design of necessary test equipment

GUIDANCE SYSTEM requires individual with design and fabrication experience for subcontractor control and to assure that the delivered guidance system is accurate and reliable To achieve this goal the tasks range from purest analytical study to configuration control

DESIGN ASSURANCE and RELIABILITY

Specialists including top level supervisory and individual contributors at all levels of professional and academic achievement, with strong backgrounds in either design engineering or reliability or both

Tasks involve TECHNIQUE DEVELOPMENT in the following

SYSTEMS User Operations Analysis, Reliable System Design, System Reliability Models Cost/Effectiveness Evaluation, Man Machine System Analysis

COMPONENTS Reliable Hardware Design, Hardware Analytic Evaluation, Component Evaluation, Parts and Materials Selection Specification Criteria, Supplier Programs and Evaluation

Openings exist for experienced engineers with applied higher mathematics education, preferably in statistics. BS degree required, higher degrees preferred Circuit analysis with transistor and diode experience is also desirable

AERODYNAMICS

BS or MS in AE or ME with experience in aerodynamic loading, hypersonic or supersonic flow, calculation of aerodynamic coefficients, and trajectory determination, to perform research and development into the space flight regime and space environmental conditions Must have above average analytical ability

EXPLORE THE IDEA of growth and advancement with one of the nation's prime aerospace firms, a company whose name is synonymous with leadership in a broad range of pace-setting industrial activities. Among dozens of active study contracts and in-process hardware projects which assure far-ranging challenges to Astronautics staff members at all levels of experience are Nova, Centaur, Atlas SLV III, lunar logistics vehicles, solar monitors and an impressive array of orbiting and space probe vehicles. Consider the scope of these projects, match your interests and abilities with the activity descriptions at left —visualize yourself at Astronautics, where the professional climate favors your career and the sunny San Diego climate favors your family's year-round enjoyment of life.

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Openings also exist for graduate engineers in the following:

STRUCTURAL DESIGN, RELIABILITY, ELECTRONIC DESIGN AND DEVELOPMENT, OPERATIONS AND SYSTEMS ANALYSIS WELDING ENGINEERING, MECHANICAL DESIGN, STANDARDS AND CALIBRATION LABORATORIES, and TECHNICAL WRITING

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In anticipation of further advancements, we are interested in contacting engineers at both senior and intermediate levels Salaries are excellent as are living conditions and opportunities for reimbursed graduate study.

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How Goodyear "Engineered Value" solves tough flight problems

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PROBLEM: Better, lower-cost braking.
SOLUTION: "Ring Disc" wheels and brakes.

"Engineered Value" Advantages: Longer lining life. Permit tire change without necessity of brake removal. Lower brake pedal loads. Resist brake fade. Structurally fail-safe. Provide visual wear indication.

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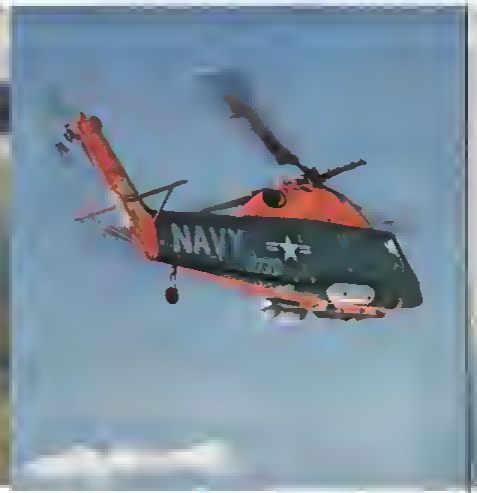
PROBLEM: Short jet tire life.
SOLUTION: "Red Streak" Jet Tire.

"Engineered Value" Advantages: Up to 15% more landings per tire. More rubber at wearing surface. Shredded wire shield resists cuts and cut growth. Has built-in wear indicator. Assures more retreads.

FOR THE NAVY



PROBLEM: Helicopter rotor deicing.
SOLUTION: Iceguard.

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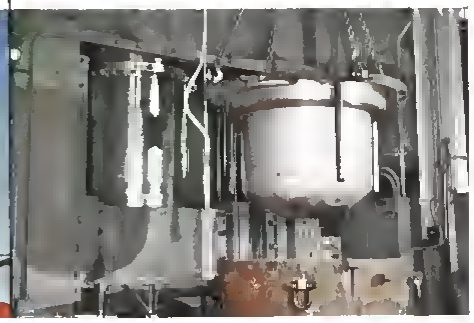
PROBLEM: Heat-shield missiles.
SOLUTION: Goodyear Thermal Shield.

"Engineered Value" Advantages: Withstands 6 000-7 000°F-ablating environments for 60-90 seconds. Takes gas speeds on surfaces up to Mach 1. Below: 5,000 ton press and missile liner molding equipment.



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GOODYEAR
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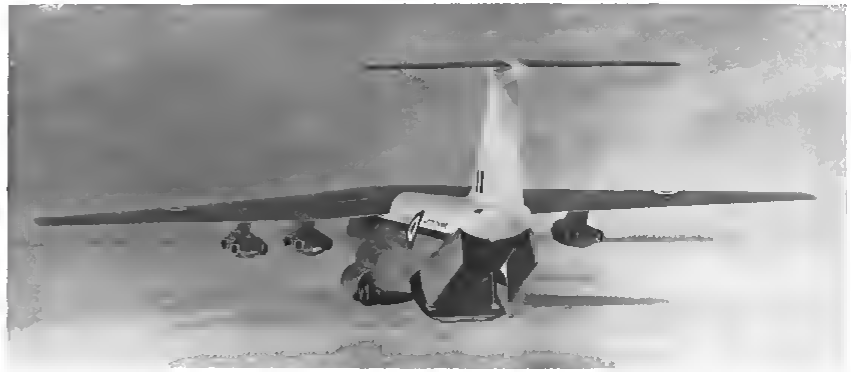
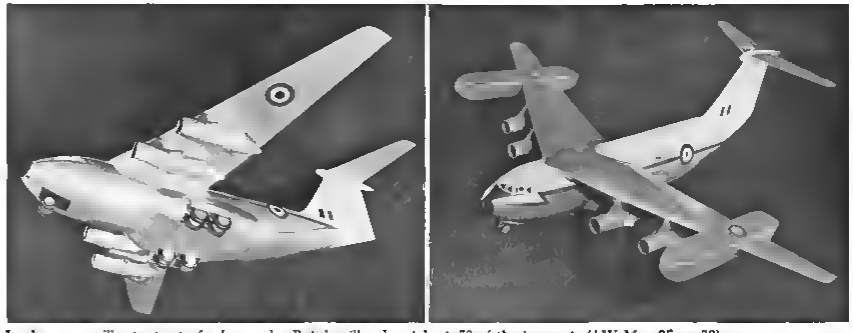


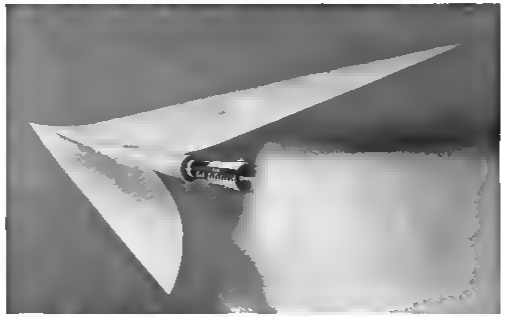
Models show configuration and engine placement of Gloster Whitworth AW-681 V/STOL freighter for Royal Air Force Transport Command. Four Bristol Siddeley Pegasus engines are located in pods under aircraft's swept wings. Note clamshell door for rear loading.

AW-681 Pegasus, RB.162 Engine Placement Shown

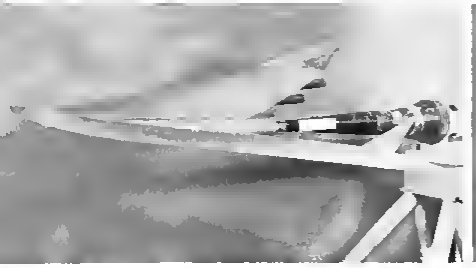


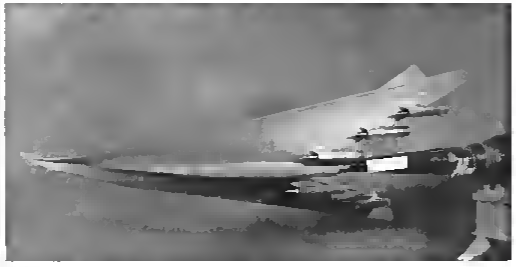
Landing gear will retract into fuselage pods. British will order at least 50 of the transports (AW Mar. 25, p. 39).

Follow-on version will incorporate batteries of Rolls-Royce RB.162 pure lift engines fitted outboard of the propulsion powerplants.



Evolution of supersonic transport concepts in NASA's research program had its early beginnings (above left) with a configuration tested as part of the Air Force B-70 Mach 3 bomber development. It featured fixed canard configuration. Models stressing highly cambered arrow wing (above right and below) were one of several dozen configurations which evolved from the supersonic bomber program. SCAT 3, a variable incidence model of canard type (p. 59, above left), was designed for reduced friction drag by use of very thin surfaces and minimum surface area. SCAT 5 (above right) featured a high lift coefficient for better takeoff and landing characteristics. Surface area proved to be too great. NASA has also studied the delta planform (below left). This is the configuration that is being used for the British-French Concorde design. Supersonic area rule concepts of the space agency's Richard T. Whitcomb were tested in SCAT 4 (below right). This model features indentation in fuselage, and engine nacelles are mounted at the top and the rear of the wings of the aircraft.





Foreign Competition Is Accelerating U.S.

By Edward H. Kolcum

Langley, Va.—Government and industry are translating a vast amount of aeronautical research, engineering and economic theory into a stable of base point supersonic transport configurations and components from which the airframe industry can select the next generation U.S. commercial aircraft.

The big push for a supersonic transport program, however, does not stem from any new found technology. It is a belated reaction to the direct challenge to U.S. aviation leadership by Britain and France with their Concorde Mach 2 transport program. Less apparent, but just as real, is the active Soviet supersonic transport program, which could produce a shock in this country similar to that of Sputnik 1.

It is unlikely that the U.S. will forfeit its leadership in the face of these challenges. Within the next 60 days, President Kennedy is expected to endorse a full scale development program with an ambitious target date of 1967 for the first flight of a prototype and introduction of the supersonic transport into service five years later.

The factors which enter the decision to proceed with this program combine to make it the most complex aeronautical development attempted by the U.S.

From a funding standpoint, Congress will be asked for a Fiscal 1964 supplemental appropriation of about $150 million—at a time when both House and Senate are calling for reduced federal spending. U.S. airlines are not able to underwrite part of the SST development costs, or at this time to buy the product which results.

Consequently, it is clear that the government faces the prospect of bearing the entire program cost for the next five or six years, and the bill for the program could be as high as $1 billion.

The President, however, is eager to get the program off the ground, and recently asked Vice-President Johnson to act as the focal point for the agencies which are drawing up the national position. Johnson is chairman of the National Aeronautics and Space Council, which has met on the SST several times.

Operationally, the U.S. supersonic transport has the most severe constraints and off-design requirements ever established for an aircraft, military or commercial. Also, for the first time in commercial transport development there is no military prototype information on the-shelf on which to establish the design base. In effect, the national storehouse of air transport technology is depleted.

There is no lack of supersonic transport theory in the U.S., but until recently no attempt was made to coordinate the theoretical bits and pieces into a family of configurations to the point where the country can proceed with confidence in developing a Mach 3 transport. One official close to the program said if there were one-fifth as much fact as there is talk about the supersonic transport, the country would be in good shape.

Research and development related to B-58 and RS-70 supersonic bombers indicated fairly clearly that supersonic cruise flight can be efficient. But the operational techniques, economics, public acceptance and safety standards of a commercial transport combine to eliminate the airframe and engine configurations developed for these aircraft.

Mission guidelines for the supersonic transport require at least a Mach 2.3 aircraft with a growth potential to Mach 3.5. It must operate economically both at design supersonic speeds, and at off-design low speeds. It must be able to compete in efficiency with subsonic commercial jets, be able to operate from existing runways, and be compatible with traffic pattern and navigation systems which will be in use in 1970. Its airframe life should be 50,000 hr. and time between engine overhaul, 2,000 hr.

Whether these guidelines are realistic is problematical, because until now there has not been enough analysis in depth to come up with a configuration which will most nearly satisfy all requirements.

British-French Concorde, while it is the most immediate challenge, does not represent the quantum jump in technology dictated by the U.S. guidelines. Nevertheless, U.S. carriers will be forced to buy the Concorde to compete in the international air traffic market—unless there is a U.S. supersonic transport under development.

Concorde will be built in two configurations, French medium range and British long-range. Both will have delta planform structures of aluminum, restricting the cruise speed of Mach 2.2. The aircraft will be powered by four underslung Olympus turbojet engines, which were designed for the TSR-2. Olympus development engines were flown in a Bristol Siddeley Vulcan testbed about 100 hr., but this part of the Concorde development program was set back last fall when the Vulcan burned on the ground.

The British and French feel their lead in SST over any potential competitor is 3-4 yr. While this is a distinct threat to a further flow-of-gold imbalance there are few in the U.S. supersonic transport program who do not feel that the real competition comes from Russia.

The current program status, consequently, represents a joining of government and industry capability against the USSR under a banner carried by the Federal Aviation Agency. The goal is a sizable advancement in the technology and philosophy of air transport with prestige as a significant factor. The most important factor, however, is the rich free world air traffic market potential, estimated as high as $4 billion.

As chairman of the national management team, FAA has received $31 million in Fiscal 1962 and Fiscal 1963. The Fiscal 1964 budget has not been specified, pending the decision to go

into development which Najeeb E. Halaby, FAA administrator, will make next month. National Aeronautics and Space Administration provides basic research information for the program, and furnishes technical support. Air Force also provides technical support and furnishes a sizable contracting staff to help FAA.

FAA is committing between 65-75% of the $31 million it has received to powerplant and engine studies. The agency also has awarded component study contracts in the areas of structures, materials, flight controls, aerodynamics and subsystems.

In order to tie much of its own and industry's generalized research into a state-of-the-art guide, NASA awarded $500,000 contracts to Boeing and Lockheed early last February to analyze four conceptual supersonic commercial air transport (SCAT) configurations from an engineering, rather than a theoretical viewpoint.

The two companies were told to evaluate the over-all feasibility of the configurations, match the configurations with four paper engines, and finally, to establish baseline information on compromises and tradeoffs which must be invoked to achieve a realistic supersonic transport.

The NASA configuration studies are being managed by Langley Research Center, with direct management by many of the same men who worked on the Air Force WS-110 (supersonic bomber) research program. Charles J. Donlan, Langley associate director, emphasized that the Boeing and Lockheed conclusions will not be a single design, but rather will specify the features and shortcomings of the concepts being analyzed. With this information, Donlan said, an airframe company will have fundamental data on what each configuration can do when the company itself selects a design.

The four SCAT configurations under study represent a synthesis of the most promising designs which have been theorized by Langley and Ames Research Centers during the past six years. In this period NASA, which was operating on a tight aeronautical research budget, conducted studies of 17 promising SCAT shapes. The four on which the agency decided to focus emphasis have survived realistic wind tunnel flow conditions in supersonic transport flight regimes. SCATS 4, 15 and 16 were developed at Langley, and SCAT 17 at Ames.

Principal features of these models are the following:

- **SCAT 4** is characterized by a fixed arrow wing, and full exploitation of the area rule to reduce drag. Critical design point is positioning the four engine pods to overcome flow problems.
- **SCAT 15** also has an arrow wing with variable sweep wing positions for low, medium and high speed flight. The wing is twisted and cambered to reduce drag due to lift. Wing and fuselage are blended to minimize wave drag, and the four engines are underslung. When not deployed, the variable sweep wings are superimposed on fixed high-speed wings. Small outboard tail surfaces improve stability and trim characteristics.
- **SCAT 16** has a variable sweep arrow wing. It differs from SCAT 15 in that it has no fixed high-speed wing structure or outboard tail. It is a three-engine configuration, with two engines slung under the wing, and one stacked on the aft end of the fuselage. Wings are cambered and twisted, and the horizontal tail has a large negative dihedral.
- **SCAT 17** is a canard delta configuration with fixed wings. Forward canard surface is movable. Study of this concept is designed to wring the maximum information from research which has gone into the RS-70, which the model closely resembles. A tail is deflected upward to provide subsonic trim, and downward in supersonic flight for directional stability.

In optimizing cruise performance, NASA theoreticians were forced to consider in detail wave drag, which does not exist in subsonic operation, and friction and lift drags, which exert considerably greater influences on the faster aircraft. Combined drag forces on the supersonic transport are about three times the value of the forces on a subsonic aircraft. As a result, each of the SCAT configurations reflects a slender fuselage and thin lifting surfaces to minimize shock wave drag. Friction drag is related to background roughness. Mark R. Nichols, chief of Langley's full-scale research division, feels that the gaps and steps between adjoining panels must have tolerances no greater than 0.008 in.

Trim drag, or drag due to lift, may be minimized by increasing the wing panel aspect ratio, illustrated in the narrow wing shapes, and by twisting and cambering the wings. Aspect ratio of SCAT 4 is about 2.3, and SCAT 17, about 2.2. This value increases significantly in variable sweep designs. SCAT 15 ranges from 2.0 to 8.2, and SCAT 17 from 1.4 to 9.3, depending on the degree of sweep.

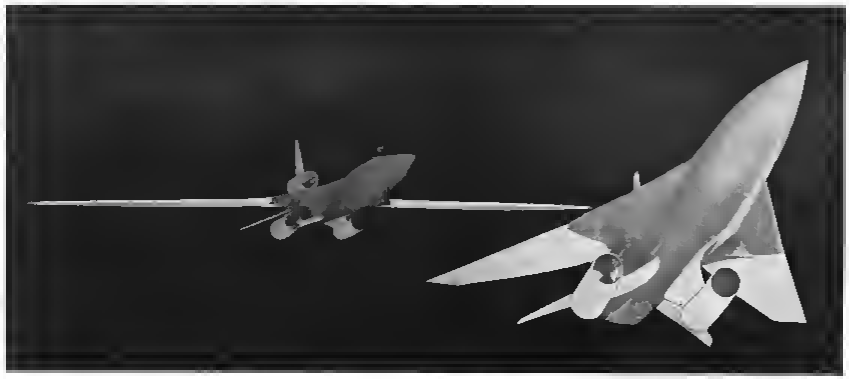
Engines to be matched to the airframes are divided into two categories, each containing an augmented turbojet and a turbofan. Nichols said one set of engines is slightly beyond existing technology in terms of inlet temperatures, and the second set is well advanced both in use of variable geometry and inlet temperatures.

Like the total SCAT system, the powerplant has a number of special operating requirements. Nichols said the engine must have low jet velocities, or greatly improved noise suppressors to reduce noise levels below those for existing subsonic jets. They must have a high degree of thrust augmentation so that acceleration above Mach 1 can be made at high altitude. They must be light, operate at conservative temperatures, and be efficient in the off-design operation.

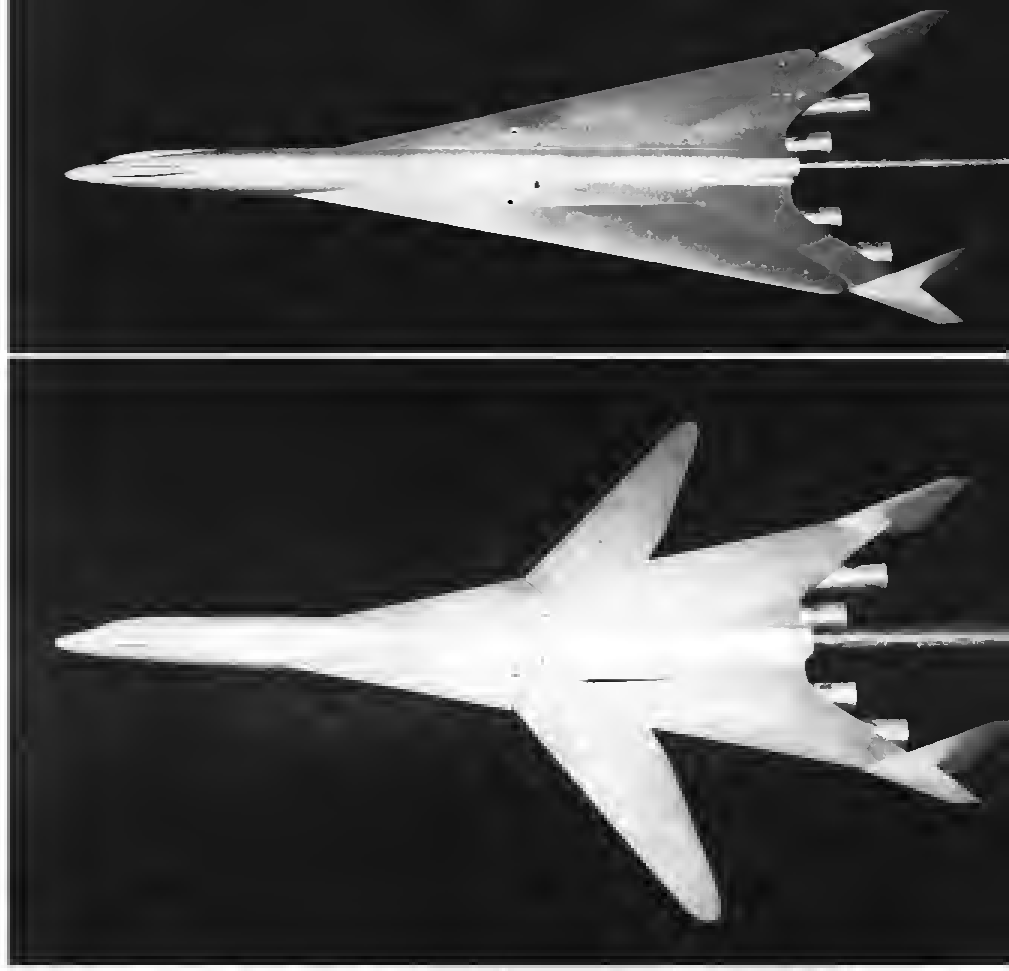
The configuration study program is being conducted independently by FAA and USAF by NASA. Although FAA felt the studies should be a part of the over-all joint management, NASA argued successfully that the research aspects are more realistic if they are not influenced by a regulatory agency—FAA—or a potential customer—USAF.

There is a close relationship between all three members of the management team through a top-level steering committee and a working group. Steering committee members are Halaby, Charles H. Zimmerman, director of NASA aeronautical programs, and Brockway McMillan, assistant Air Force secretary for research and development. The working group consists of technical experts from FAA, USAF and NASA who advise FAA where it should commit its research money. FAA has awarded about 45 contracts to date, mainly in powerplant work, and expects to have about 80 contracts in force by the end of June.

The process through which NASA found itself in a position to focus design consideration on four configurations began in July, 1957, when the agency began wind tunnel and analyti-



SCAT 16 IS A THREE-ENGINE configuration with variable sweep wings. It differs from SCAT 15 in that it has no fixed high-speed wing structure or outboard tail. Horizontal tail has a huge negative dihedral.



SCAT 15 FEATURES VARIABLE WING sweep to aid efficient operation at low, medium and high speeds. The wing is twisted and cambered to reduce drag due to lift. The four engines are mounted beneath the wing.

cal research in the WS-110 program. A family of generalized commercial transport research models was developed during the next two years, but because aeronautical research money in NASA was hard to obtain, the agency could not proceed along the same route that its predecessor agency, the National Advisory Committee for Aeronautics, had historically employed.

In the days of NACA, the usual practice was to call on industry for engineering verification of NACA theory. The money problem was a sign of the times—NASA was emphasizing the space part of its charter and the air transport industry was not anxious to discard its new passenger jet aircraft so soon after they went into service.

The British-French pact to develop a Mach 2 transport became the real challenge to accelerate the U.S. program in mid-1962. But the U.S. lost valuable time because it would not commit money to verify or discard the sizable number of theoretical configurations which had been generated.

The first SCAT model was produced in mid-1959. It had variable sweep wings, and it demonstrated in the wind tunnel serious stability shortcomings. During the next two years, the SCAT family grew to 17. Several configurations demonstrated exceptional performance in either subsonic or supersonic flight, but most were eliminated because they could not combine qualities in both flight regimes.

Donald D. Baals, assistant chief of Langley's full-scale research division, pointed out that SCAT 3 was an excellent configuration in high subsonic and supersonic flight, but was severely limited in low-speed performance. Other configurations rejected in the elimination process because of performance deficiencies were the variable sweep SCAT 5, which featured fore and aft tails; SCAT 9 was the start of the concept in which wing and fuselage were blended; SCAT 11 had engines stacked on a high tail, and SCAT 14 combined the TFX variable sweep tail with RS-70 engine inlets.

Concurrently, NACA had developed a family of four promising bomber configurations, and reported on them in mid-1958. All featured fixed geometry wings, and one, the canard delta configuration, was selected for the RS-70 program. The other shapes were an arrow wing like SCAT 4, another arrow wing with outboard tail surfaces, and a tailless delta.

By mid-1960, NASA was able to define the major problem areas foreseen in the SCAT program on the bases of WS-110 and commercial transport research theory. The general problem areas were defined as noise, structures and materials, loads and flying and handling qualities.

Six months later, the joint FAA-USAF-NASA supersonic transport program was published. Last June, the Supersonic Transport Advisory Committee published a list of research guidelines. These guidelines were incorporated into the task which has been assigned to Boeing and Lockheed.

- **Mission**—objective is a Mach 3 aircraft with a 3,500-mi. range, a 25,000-lb. payload, and sufficient volume to carry 125 tourist-class passengers and their baggage. The aircraft also must be capable of subsonic speeds over stage lengths of from 200-1,000 mi. Economy of operation of a Mach 2.3 interim transport also is being examined. This transport would have a range of 1,000-2,400 mi. Boeing and Lockheed will prepare range and payload charts for subsonic, Mach 2.3, Mach 2.6 and Mach 3.0 flight.
- **Operations**—the studies assume the SCAT will operate on a 9,500-ft. runway, and have a landing roll of 7,000 ft. or less. Requirement to use existing runways places a top limit of 80,000 lb. as the equivalent single wheel load. Depending on the full load, this would be a gross weight of 315,000-450,000 lb.
- **Utilization**—perhaps the toughest requirement in contrast to RS-70. Airframe life of 30,000-50,000 hr., and time between engine overhauls of 1,000-2,000 hr. are specified. The companies will analyze the effect of 6, 8 and 10 hr./day utilization rates.
- **Flight characteristics**—specifications now call for 15-min. taxi power, 60 sec. at takeoff thrust, and a speed buildup so that Mach 1.05 is not attained until the aircraft reaches 40,000 ft. Because of sonic boom and overpressure hazards, these additional speed/altitude restrictions are specified: Mach 1.4 at 50,000 ft., Mach 2.0 at 55,000 ft., Mach 2.5 at 58,000 ft., and Mach 3.0 at 60,000 ft. Low speed requirements in takeoff, landing, loitering and holding in the traffic pattern should be better than the characteristics of contemporary subsonic jets.
- **Operating costs**—studies will determine how these costs are influenced by cruise procedures. Goal is to have an aircraft with unit mile costs lower than contemporary jets. For the study, a 200-aircraft market is assumed.

The propulsion requirements also use the subsonic jet transport as the baseline. Nichols said the engine should have a noise level no higher than present jet transports, engine weight must be low and cruise specific fuel consumption less than for present supersonic dash aircraft. The reliability, durability and life should be competitive with engines of present jet transports.

Boeing and Lockheed will determine tradeoffs in weight, payload, range and noise for the four specified paper engines, and will select a powerplant best suited for each configuration. The study will involve an evaluation of both internal and external aerodynamics of the complete power package as well as a determination of the weights of the engine systems.

A critical restraint in engines is associated with the noise problem, and this multiplies the complexities of matching the engine and airframe particularly in the off-design, slow-speed, regimes in which the engine will take off, climb, loiter and land.

Laurence K. Loftin, Jr., assistant Langley director, said the studies will be due eight months from the Feb. 3 award date. A formal review will be held in May, and informal reviews will be held continuously. In addition, Langley has assigned a man to each contractor plant as liaison.

Douglas, General Dynamics and North American also bid on the feasibility study award. Source selection was done at Langley with Langley headquarters, Ames and Flight Research Center representatives on the board. Before the final selections were made, several technical evaluation groups examined specific disciplinary areas. FAA and USAF were represented on these evaluation teams.

With the data from the studies and the continuing NASA in-house research program, Donlan feels the country will be in a position to determine if SCAT technology is available to provide a competitive aircraft in the transport market.

"There is no question that we can build a supersonic transport," he said. "The question is, will it be like the DC-8 and 707, or will it be a prestige item?"

Defense Export Market

Washington—Potential export market for American defense industry during coming decade is expected to range from $11-13.2 billion, roughly double the defense exports during the last 10 years.

Concerted effort is required to achieve this potential, according to William P. Bundy, deputy assistant secretary of defense for international security affairs. He told the marketing symposium of the Electronic Industries Assn. here that military, economic and political factors within individual foreign governments could adversely affect the market.

Lawrence Levy, Defense Dept. representative in the North Atlantic and Mediterranean areas, said that the North Atlantic Treaty Organization's important military requirements for the 1970s include a defense against tactical ballistic missiles, air and surface-launch missiles, data handling systems for ships and aircraft and communications.

Du Pont announces

TD NICKEL SHEET

First commercially available dispersion-strengthened* sheet material capable of sustained service at 1800° F to 2400° F!

TD NICKEL SHEET is now available in commercial quantities. It offers broadened opportunities for the design of components and equipment capable of sustained operation at temperatures up to 2400° F. Consider these facts:

1. High temperature strength

Compared to superalloys, TD Nickel sheet has notable advantages in both high temperature tensile and stress rupture strengths. For example, *typical* ultimate tensile strengths of TD Nickel sheet are:

1800° F—20,000 psi
2000° F—16,000 psi
2200° F—10,000 psi
2400° F— 4,000 psi

2. High temperature stability

Unlike superalloys, TD Nickel sheet can be thermally cycled to 2400° F with little or no sacrifice in its mechanical properties.

3. Formable at room temperature

TD Nickel sheet can be worked similarly to nickel—at room temperature. It can be formed and machined using standard metalworking practices. No solution anneal followed by an aging heat treatment is required to develop strength. Brazed joints are readily produced (welding methods are under development).

Sheet sizes available

TD Nickel sheet is available in gages from .010 in. through 0.187 in., widths up to 24 inches and lengths up to 36 inches. Foil gages are available on special order.

Bars available, too

TD Nickel bar is also commercially available—in diameters of ½ in., ¾ in., 1 in. and 1¼ in.—all in 20 foot lengths (annealed). Technical data are available. See below.

Full information

For complete descriptive information, write on your company letterhead or use the coupon, below. (To aid our reply, please list your particular end-use interest.)

*TD Nickel is 98% nickel and 2% thoria (by volume)

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☐ Du Pont TD Nickel sheet
☐ Du Pont TD Nickel bar

I am interested in the following possible applications

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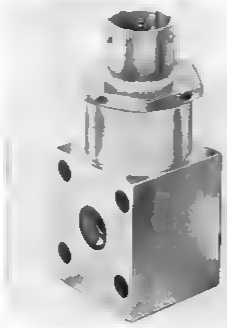
NEW AEROSPACE PRODUCTS

Miniature Explosive Valve

Electrically fired precision explosive valve designed for space engine fuel control can be used in applications where instantaneous opening of ¼ in fluid or gas line with totally unimpeded flow is desired

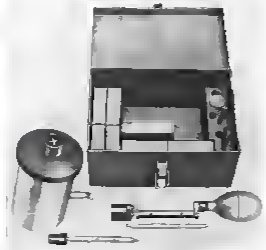


Valve Model 3380 gives unrestricted flow in 4 milliseconds. Unit is all welded, leak free, and of stainless steel construction. Design eliminates any involuntary welding of metals under a space environment, the manufacturer says. Valve is 1.73 in. x 1.00 in. x .750 in. and fits directly into the flow line. Ram lips at the bottom of the piston flare upon impact, after firing, with the base of the valve and lock the piston in the open position.

Pyrodyne, Inc., 11876 Wilshire Blvd., Los Angeles 25, Calif.

LOX Contamination Detector

Liquid oxygen Contamination Detector Kit is capable of estimating extremely low concentrations of unsaturated hydrocarbons and carbon dioxide, the manufacturer says.



Unit comes with a stainless steel 200 milliliter liquid sample container, an aspirator bulb with a two-orifice turret-type head, sealed glass detector tubes and air filter tubes. Turret-type two orifice aspirator head allows quick switching from hydrocarbon to carbon dioxide testing.

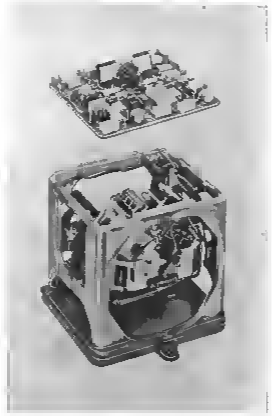
Hydrocarbon detector tubes will indicate vapors in the range 1 to 100 ppm representing .003 to .300 ppm in the original sample. Carbon dioxide tubes have the range of 0.05 to 1% by volume corresponding to an initial 1.6 to 31.4 ppm. Kit comes in a metal case and weighs 6¼ lb.

Mine Safety Appliances Co., 201 No. Braddock Ave., Pittsburgh 8, Pa.

Improved Gyro

Improved vertical gyro with high static accuracy and low free drift measures 4¼ in. x 6¼ in. and weighs 5¾ lb, the manufacturer says.

ARG-5 Vertical Gyro uses capacitor-type pickoffs to sense roll and pitch and drive the erection torquers to maintain gyro verticalness. Gyro is hermetically sealed in a dry nitrogen atmosphere.



Free drift is .15 min. of arc per minute exclusive of the earth's rate; static accuracy is one minute of arc. Variable erection rate of 1 to 15 deg. per minute is provided and unit is available with d.c. output signals. Applications include: stabilization of aerial camera mounts, aircraft radar antennas, flight control instruments, and guided missiles.

Aeroflex Laboratories, Inc., South Service Dr., Plainview, L. I., N. Y.

PRODUCTION BRIEFING

Correlated Data Systems Corp., Glendale, Calif., will build a power simulator for spacecraft solar panels under a $100,000 contract from Jet Propulsion Laboratory. Unit will be used to incorporate advanced current-feedback circuitry and simulate power sources of future space vehicles.

Lear Siegler's Instrument Div. will design and develop secondary attitude and reference systems for Air Force's RF-4C reconnaissance jet under a $900,000 contract from McDonnell Aircraft.

Kearfott Div. of General Precision Aerospace has received a $434,000 contract from Jet Propulsion Laboratory to produce float-rate, integrating gyros, which will be used on future Mariner spacecraft scheduled for planetary investigations of Mars.

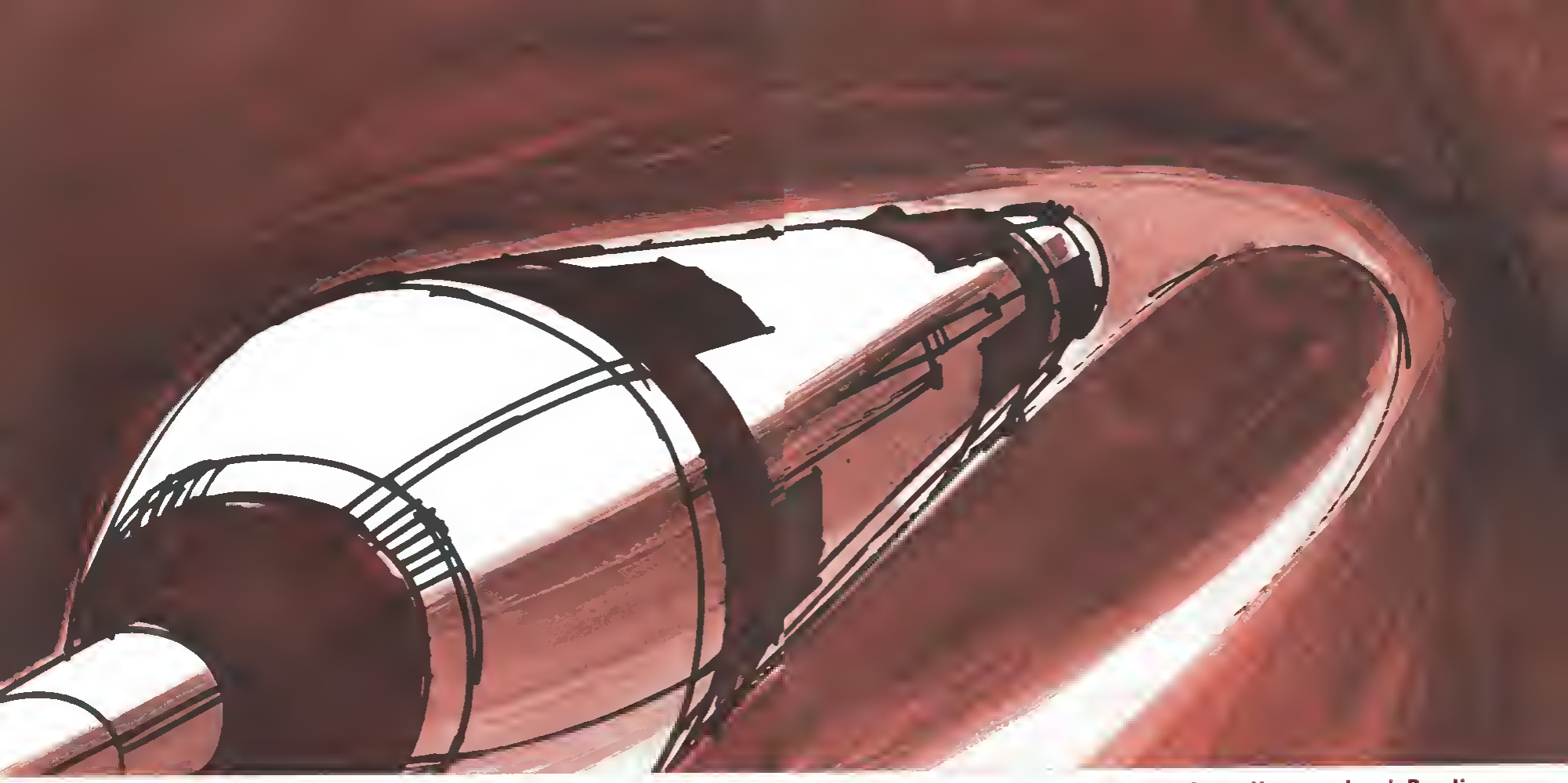
Bendix-Pacific, North Hollywood, Calif., will supply hydraulic actuator systems for the Polaris missile jetavator thrust vector control under a $1.8 million contract from Lockheed Missiles and Space Co.

American Machine & Foundry Co. has been awarded a contract from McDonnell Aircraft Corp. to design and build a mobile training device which will permit simulation of Gemini spacecraft landings on terrain or water. Spacecraft will be suspended from an overhead track and fired by a catapult, which will hurl it from its guiding rails at the spacecraft's landing speed of about 68 mph. horizontally and 10 mph. vertically.

H. I. Thompson Fiber Glass Co., Los Angeles, Calif., is developing 120-in. dia. reinforced plastic nozzles for Air Force's Titan 3-C first-stage booster under a contract from United Technology Corp. First full-scale test nozzle will be delivered in mid-1963.

Ramo Wooldridge Div. of Thompson Ramo Wooldridge, Inc., will develop two automatic map compilation units capable of producing topological maps from aerial photo data under a $1.75 million contract from Army's Engineer Geodesy, Intelligence and Mapping Research and Development Agency.

Northrop's Nortronics Div. will design and develop a speed and indicating system capable of withstanding 15,000-ft. depth ocean pressures for a deep-diving aluminum submarine being built by General Dynamics' Electric Boat Div. Submarine will be used by Reynolds International, Inc., for oceanographic research.



Thrust vector controls... from the people at Bendix

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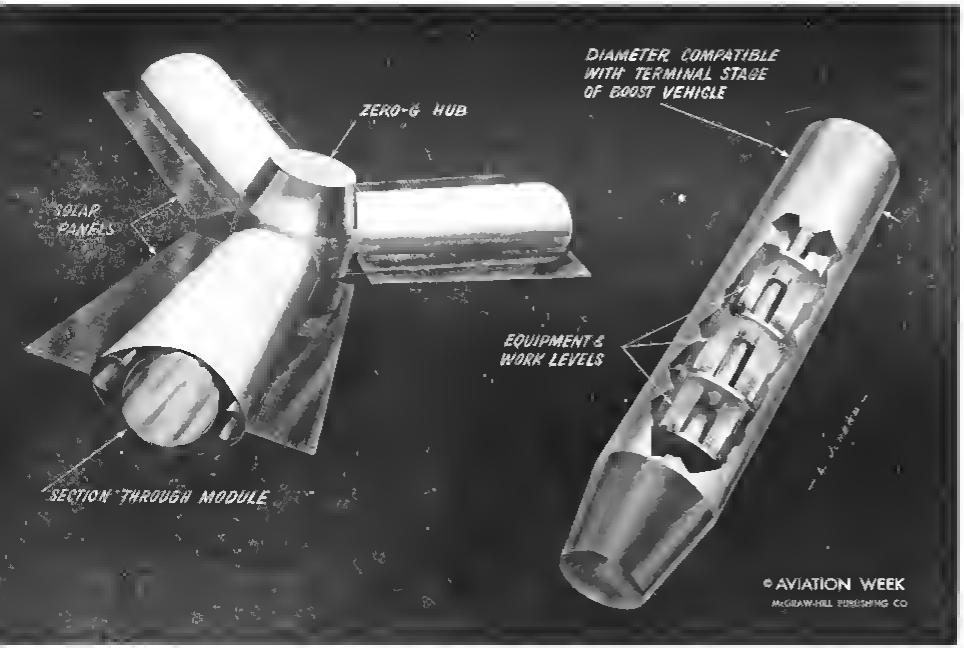


ROTATING RADIAL MODULE configuration for a space station with hub for zero-g environment (left) has 9,000 cu ft volume in each compartmented module. Non-rotating zero g cylindrical configuration (right) incorporates various levels for crew and equipment

NASA Seeks Space Station Parameters

By Irving Stone

Los Angeles—Series of studies to establish the framework of technical requirements for a manned earth-orbiting space station and its associated logistics is being supported by National Aeronautics and Space Administration's Manned Spacecraft Center (MSC).

Spacecraft projections indicated as common denominators for all the studies include radial-module and cylindrical arrangements. Included in the group of studies are these successive efforts:

• **Configuration analysis.** This study is programmed to begin in Fiscal 1964. Objective will be analysis of engineering, operational and human factors to provide final design criteria for the manned orbiting station and re-supply logistics spacecraft.

• **Operations and logistics study.** Aim of this analysis is to establish requirements necessary for program definition, preliminary design and use of the manned station and a compatible logistics spacecraft. Two configurations are being considered in this study—a radial module with a rotating capability to simulate an artificial gravity environment for the crew, and a non-rotating configuration providing no gravity environment. Conceptual detail of these configurations will be furnished to the study contractor.

Industry proposals for the study were submitted to MSC last month. It will be a six-month effort encompassing about 10,000 man hours. A cost-plus-fixed fee contract is anticipated, but cost-sharing or a fixed-price arrangement will be considered.

• **Environmental control** and life support system study. Effort here will be to analyze the parameters to optimize such a subsystem. A three-radial module space station as well as a single-module, non-rotating cylindrical station are specified. Industry proposals also were submitted last month for this effort. A six-month, 5,000-man hour study is anticipated under a cost-plus-fixed fee contract, but cost sharing or fixed-priced contracts also are under consideration here.

Supplementing this study is another effort under cognizance of Langley Research Center for a forerunner life support system. Proposals were submitted last month for an 18-month task involving preliminary and detailed engineering design specifications and drawings and system fabrication. The system anticipated is a ground-test installation for a four-man station based on use with two or three Gemini vehicles in space (AW Jan. 14, p. 28). Langley also sponsored last year the first NASA study of the basic parameters of a space station anticipating re-supply by Apollo vehicles (AW Nov. 12, p. 56).

• **On-board electrical power** system. This six-month, 5,000 man-hour study, for which proposals were submitted in February, calls for analysis of power requirements for a space station with a crew of 18 to 30. One of the two station configurations specified for the study also is a three radial-module arrangement.

Details of the three-radial module station specified for the MSC environmental control and life support system indicate that it will orbit the earth in a 200- to 300-naut. mi. circular path and will be designed for a useful life of one to five years. The station will embody a partial artificial gravity (0 to 1g) for the radial module portions, and a zero-g cabin which will be included as a hub for the radial modules or as a separate auxiliary facility adjacent to the station.

Radial module station will be packaged for stowage compatibility with the launch vehicle and will be deployed in orbit. Zero g center section will be about 33 ft. in diameter. Modules, approximately 15 ft. deep, will extend about 42 ft. from the center section periphery.

Each radial module will be self-contained, divided into several compartments. Cabin volume of each module will be approximately 9,000 cu. ft. and will accommodate a normal crew of six men or a peak crew of 12. Total normal station crew of 18 will have to be supported continuously. Peak crew of 36 must be supported for several days.

Seal Environment Study Proposals

NASA's Manned Spacecraft Center has requested industry to submit proposals for a three-month, 1,500-man-hour study to recommend materials, configurations, and leak detection and repair procedures for seals to be used in a manned space station.

Space station concepts (see story) for the study include a three-radial-module arrangement or a modified-toroidal configuration orbiting in a 200- to 300-naut. mi. circular path and having a minimum life of one year and a possible life up to five years.

Contractor tasks will include these investigations:

• Comprehensive study of available data on out-gassing effects of ultra-high vacuum on organic and inorganic materials.

• Effects of thermal cycling on seal materials. Limited thermal shielding or insulation may be investigated if adverse effects of temperature extremes cannot be prevented by choice of materials.

• Study of available data on effects of ultraviolet radiation on potential seal materials.

• Material degradation caused by high-energy radiation. Limited amounts of shielding or periodic replacement of material may be investigated if degradation cannot be prevented.

• Problems of penetration and abrasion of materials by meteoroid particles.

• Automatic leak detection for sensing ruptures of all sizes and triggering of an alarm system to indicate the location and severity of the leak.

Seal configurations recommended will have to be applicable to air locks, hatches 3 to 10 ft. in diameter, umbilical connectors, rotating joints and shafts, and rotating and sliding seals.

Crew Environment

Crew will work in a "shirt-sleeve" environment but provisions will be available for charging and using portable life support systems.

Total cabin volume of the compartments in the single-module zero g station configuration—a non-rotating cylindrical unit—will be approximately 50,000 cu. ft. Diameter of this configuration will have to be compatible with the terminal stage of the launch vehicle for a faired arrangement.

Cylindrical station probably will contain about four or five levels to accommodate equipment and experiments. Re-supply for crew and cargo from docking vehicles could be through the nose of the cylindrical station to a central tubular passageway passing through the various levels in the station. Maximum period for re-supply of expendables will be 90 days.

Environmental control system will be required to accommodate the following conditions:

• **Oxygen consumption** of 1.8 lb./man/day. Three oxygen supply systems will be considered. These include storage of metabolic oxygen with no reclamation provisions, storage of metabolic oxygen, plus a system to recover oxygen from carbon dioxide and/or water, and a complete reclamation system. Gaseous supercritical, and liquid oxygen storage systems will be compared to determine the best storage method or combinations of them. Oxygen and nitrogen for both leakage compensation and pressurization will have to be stored to allow a 90 day use before replenishing.

• **Carbon dioxide output** of 2.1 lb./man/day. Nominal carbon dioxide partial pressure limit will be 0.1 to 0.15 psi. The reduction systems will be sized for processing the carbon dioxide production of the nominal crew, and provisions will be made to store carbon dioxide during crew overload to permit processing during low occupancy periods.

• **Heat output** of 11,200 Btu./man/day. Nominal cabin temperature of 75°F ±5°F will be required. A system capable of serving cabin temperature between 50°F and 95°F also will be considered. Equipment and experimental apparatus will have heat dissipated by the heat rejection system, but critical equipment will not depend on cabin atmosphere for cooling or pressurization and will have emergency controls.

• **Water consumption** of 6.16 lb./man/day, excluding water for sanitation. There will be provisions for reclaiming potable water from urine, wash water, and other contaminated water supplies. Water also will be collected from the atmosphere conditioning loop and stored. A method of dissociating water to form oxygen and hydrogen will be considered as supplemental to the oxygen reclamation systems.

• **Relative humidity** will be maintained within 35-70% range.

• **Cabin pressure** will be capable of variation from 3.5 to 14.7 psia., with a nominal cabin pressure of 7 psia. (containing an oxygen partial pressure of 3.5 psia.).

• **Waste management system** will include provisions for storing, dehydrating and/or reclaiming solid waste products.

Life Support System

Langley-sponsored life support system involves detailed engineering design, design data, specifications, drawings, fabrication and testing of the system. Basic size will be that of a final flight-type system but not necessarily a flight-type system from the standpoint of weight, bulk and detailed design. Duration of systems operation is targeted for six months to a year, with re-supply at 60-90 day intervals. Crew of four men will be subjected to a gravity condition in the range of 0 to 1g.

Cabin volume will be 2,600 cu. ft. Oxygen consumption will be 2 lb./man/day. Carbon dioxide production rate will be 2.25 lb./man/day. Respiration and perspiration water rate will be 2.20 lb./man/day. Cabin pressure will be 10 to 14.7 psia., and cabin leak rate will be 33.5 lb./month.

MSC study for an on-board electrical power system for a manned orbital space station also envisions a three-radial module configuration or an alternate modified toroidal shape, each capable of accommodating 18 to 30

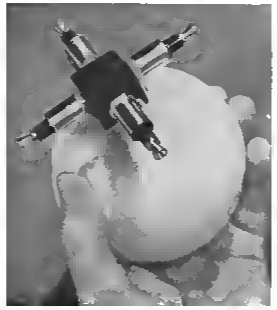
crew members in an operational regime spanning one to five years

Electrical power system must supply, regulate, and distribute power for all space station requirements. It will have to be capable of continuous operation without extensive re-supply service for periods compatible with normal mission durations.

Parametric power profile from 10 to 40 kw will include loads for navigation and guidance radar, stabilization, environmental and propulsion controls, communications, instrumentation, lighting and other equipment. Growth potential of the power supply will have to be anticipated with relation to a possible scale-up of the space station.

Auxiliary (backup) power system will be incorporated, with safety and reliability factors determining if it should be a single unit or a modular power supply. For the auxiliary power system, the use of solar cell arrays will be analyzed to determine possible conflict with mission requirements for orientation, thermal control, environmental radiation and meteoroids. A nuclear reactor (radioisotope source) or concentrated solar heat source will be considered in conjunction with thermionic generators, thermoelectric converters, rotating heat engines or other energy conversion devices.

Feasibility of orbiting significant quantities of radioactive materials will be analyzed with regard to safety, together with conflicting mission requirements resulting from remotely positioning a reactor in a boom-and-pod arrangement.



Solid Microrocket

Solid fuel rocket produces tiny control forces for adjusting the direction of satellites after they have been placed in orbit. A new kind of solid propellant, which can be turned on and off at will, is utilized according to Rocket Research Corp., Seattle, Wash., manufacturer of the rocket.

MSC's operations and logistics study for a manned orbiting space station seeks to perform basic technological investigations of the problems involved in extended missions, such as manned planetary exploration and establishment of a lunar base. Other experimental functions, such as astronomy, meteorology, communications, navigation and geophysics will be conducted on board the space station and supported by its crew.

Mission Profile

Space station also would provide a base from which to conduct orbital launch operations to support lunar and planetary programs.

Mission profile for the two configurations envisioned—a radial-module arrangement with rotation to simulate artificial gravity and a non-rotating configuration—will include trajectory, abort considerations, velocity requirements, astrodynamics, space environmental conditions, mission sequences, recall requirements, landing site selection and logistics support.

Operational and logistics analyses will consider basic economic factors of on-board and ground-based subsystems and the interfaces between them.

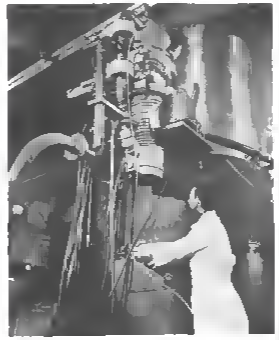
Long mission of the space station will require that the crew rotation and re-supply system will have to be treated as an integral part of the total station complex. Station design will have to accommodate efficient re-supply with regard to time and cost.

Problem Areas

Mission and design aspects will require consideration of a multitude of prime problem areas:

- **Operating environment,** encompassing factors relating to radiation (cosmic, Van Allen, solar flare, artificial belt), ultraviolet waves and meteoroids.
- **Hazards** associated with internal and external environments of the space station and logistics spacecraft.
- **Orbit activation,** such as separation from terminal stage, circularization of orbit, space station deployment and sealing, systems activation, orientation and stabilization and initiation of spin.
- **Logistics operations,** such as rendezvous aspects in relation to injection into parking and rendezvous orbits, docking details including dynamics, mechanical interfaces, and procedures; crew and cargo transfer; spacecraft release and departure, re-entry factors, such as communications and retro-forces, and landing and recovery techniques.

Over-all study will not include detailed subsystem analyses and relationships, but subsystem areas will be studied to understand operations and logistics interfaces.



Space Simulator

New space simulator is capable of reproducing the extreme cold of the dark side of the moon, the radiation of the sun, the vacuum of space and the shocks and vibration forces which occur during power take off, stage separation, stabilization and re-entry of spacecraft. Simulator costs $300,000 and was developed by United Testing Laboratories Div. of United ElectroDynamics, Inc. It is scheduled to test the Centaur subsystems for General Dynamics/Astronautics. Design, fabrication and installation of 4-ft.-dia. chamber was based on experience in aerospace test and reliability programs.

Stratoscope 2 Aims for Spectral Analyses of Planets' Atmospheres

Palestine, Tex—Major program of planetary study using the 480 ft Stratoscope 2 balloon system with its 6 300-lb payload capability is anticipated following the success of the first flight of this system Mar 1. This flight carried out from the new Scientific Balloon Center here, provided a mass of infrared scan data on Mars' atmosphere.

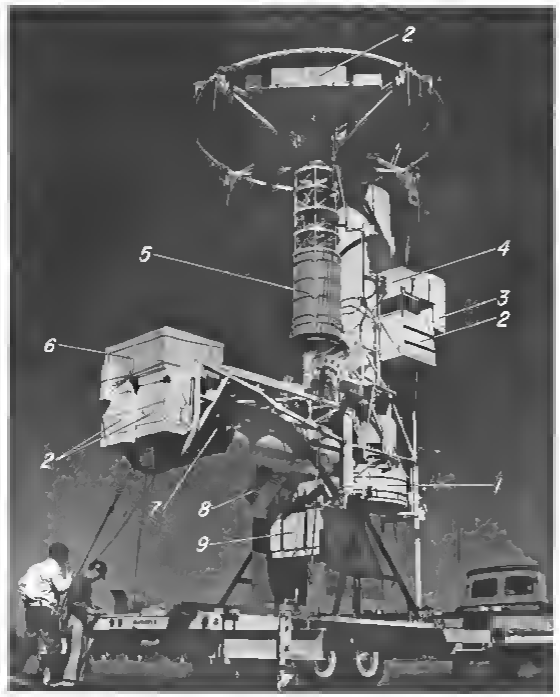
The flight recorded on tape the infrared spectra of light received from Mars by means of the telescope in the wavelength of 1-7 microns. Rough scan data was also available via telemetry records enough to indicate that tracings of water vapor and carbon dioxide were recorded. But considerable analysis must be done to subtract the effects of water vapor and terrestrial carbon dioxide that were carried aloft in the system before definitive information beyond what is already available from ground observation can be developed.

The infrared spectrometer system took light gathered by the telescope reflecting mirror and spread it into a spectral band by means of a prism. A narrow slit moving across the spectrum, permitted passage of light from each "color" segment into a radiation detector. Texas Instruments' cryogenic germanium bolometers measured the radiation of each color and converted it into electrical impulses for recording the characteristics of the gas observed. Some 1,500 ft. of tape record, comprising 14 data channels were made.

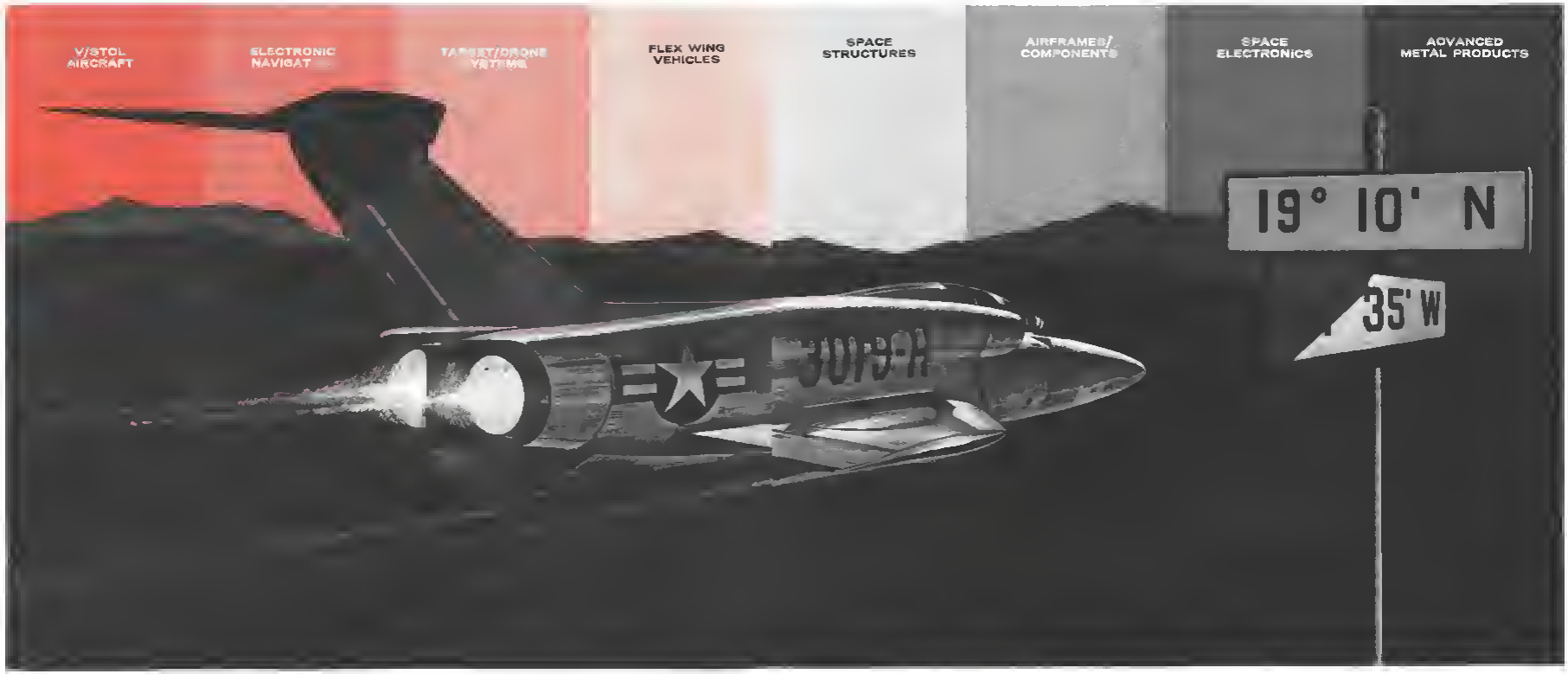
The second flight in the Stratoscope 2 program, sponsored jointly by the National Science Foundation, Office of Naval Research and the National Aeronautics and Space Administration, will attempt to perform an infrared spectral analysis of the atmosphere of Venus, Jupiter and Saturn.

Fitted with improved optics to provide resolutions necessary for photographic recording, the Perkin-Elmer telescope system used on Stratoscope 2 (AW Oct. 15, p. 73) will attempt these missions beginning late next year.

- **Cloud patterns of Venus** will be photographed in an attempt to discern their composition. One group of scientists believes that these clouds are water droplets and ice crystals, others contend they consist of dust stirred up from the surface of the planet. Ground telescope pictures have been made of cloud patterns that remain stationary for several weeks and the nature of these is also a mystery. High resolution photographs from Stratoscope 2 from 80,000 ft—96% outside the earth's sensible atmosphere and less affected by the distortion of this atmosphere—are expected to clarify the nature of these patterns.
- **Jupiter's features**, which are highly complex and generally believed to consist of immense cloud formations, will be analyzed. Because of the planet's low density—1.34, closely matching that of the entirely gaseous sun—it is believed that Jupiter is composed mainly of the lighter elements, hydrogen and helium, with the liquid and solid phases being present at great depths. Another mysterious feature is the so-called "Red Spot," some 30,000 mi. long and 7,000 mi. wide, which appears to drift in longitude with respect to the cloud systems. Its color and variations are not yet explained, although one theory is that it represents an effect in the atmosphere of a deep-lying permanent surface feature.
- **Reported but unverified** division of Saturn's three rings into several lesser rings, as well as details of the atmosphere may be uncovered by photography.
- **Surface features of Mars**, particularly the composition of the structure of its "canals," or rectilinear patterns in the bright areas, will be analyzed. This experiment will not be made until 1965 when Mars will be in good position.
- **Details of other planets**, such as Uranus and Neptune, may be detected because of the resolving power of Stratoscope 2's equipment, which is ½ second of arc—equal to the ability to distinguish two objects 30-mi. apart at 1,000 mi. Such resolutions are required for photographing Uranus, which has a diameter of 3.8 sec. of arc; Neptune, with diameter of 2.2 sec. of arc, and Mercury, with a diameter of 8 sec. of



KEY FEATURES of telescope system for Stratoscope 2 are (1) primary mirror system (2) batteries providing total of 10 kw. hr. (3) receiving and transmitting antenna package for command radio, television and telemetry, (4) telemetry, (5) mercury bearing for azimuth rotation of telescope (6) guidance electronics package (7) spectrometer location, (8) fine television camera (9) landing shock absorber pad



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RYANAV IV

Guidepost to aerial navigation with pinpoint accuracy—this is the RYANAV IV Reconnaissance, surveillance, observation, transportation, evacuation, close support—whatever the mission—the new RYANAV IV Doppler Navigator meets all navigation requirements of fixed-wing, rotary-wing, and V/STOL aircraft from zero to 70,000 feet altitude, in all kinds of weather, anywhere in the world, *without ground stations and radio aids!*

Now in production, the lightweight, versatile RYANAV IV tells the pilot *where* he is, how to get to his *destination* and how to return *home* again regardless of his flight path or altitude. This unique capability enhances mission success and reduces pilot workload. And, the RYANAV IV has successfully undergone extensive testing and evaluation by the U. S. Army, Navy, Marine Corps, and Air Force.

Ryan scientist engineer teams are also deeply involved in programs which include: design of the newest V/STOL aircraft, applications of the Ryan Flex Wing, sophisticated versions of Ryan's Firebee jet target drone, lunar landing systems, space radar systems, precision antennas, and lightweight space structures for space vehicles such as Mariner II, Saturn and Surveyor.

You are invited to consult with Ryan on how its broad spectrum of capabilities can help solve your problems from space structures to weapons systems.

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA

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RYAN
ELECTRONICS

LAUNCH BALLOON has a volume of 305,000 cu ft. and is inflated with helium.

are Pluto, farthest away and with a diameter of only .25 sec of arc, may be captured in a photograph that shows its disk larger than disks of stars can be shown.

• **Bright gaseous nebulae**, of interest to astronomers because they are areas where new stars are in process of formation and of other apparently related phenomena in our galaxy, could be closely examined by Stratoscope 2 to provide possible clues as to how our own sun was formed.

• **Study of stellar evolution** may be advanced by observing globular star clusters to learn the relative distributions of two types of stars in these clusters, including the dense inner portion.

• **Confirmation of detail** will be sought in the the Great Nebula in Andromeda, Messier 31. Ground-based telescopes possibly have resolved the M31 nucleus, where star density is large compared with that in the spiral arms, but Stratoscope 2's greater definition should clarify the details.

To further such intensified balloon astronomy programs, scientists connected with these projects would like to see facilities expanded here to simplify experiment preparation and launchings. A permanent large-capacity helium storage facility—Stratoscope 2 launch balloon is of 305,000 cu-ft capacity—is sought. Also suggested are additional laboratory space for on-site preparation of experiments and a large domed structure in which initial inflation of the balloon can be carried out to the point where it contains sufficient volume so that it has some stability in winds. Roof of the dome would be opened to permit exit of the balloon for completion of inflation and launch.

The Scientific Balloon Flight Center now consists of a 183-acre site with two buildings completed late last year. Structures include the "Stratoport," which houses the Stratoscope 2 telescope, and a two-story operations and laboratory building.

The launch area comprises 6.5 acres of asphaltic concrete arranged in fingers radiating from the center to permit launches with winds of various directions and 60 acres of graded soil capable of handling the large tired vehicles used in tethering the balloons.

SBFC was developed and is administered by the National Center for Atmospheric Research, which established a national balloon program last year to exploit the capabilities of these vehicles for scientific purposes. NCAR is a basic research laboratory, founded in 1960, and is operated by the University Corporation for Atmospheric Research, a 14-university non-profit management corporation. The corporation is under contract to the National Science Foundation.

NCAR also engages in balloon research projects such as improved balloon films, launching techniques, tracking and telemetry. The station is open to all scientists with balloon experiments to fly, within practical limits. NCAR terms the SBFC station here as the first year-round facility devoted exclusively to scientific ballooning.

Indications are that German astronomers are also interested in using these facilities for performing spectroscopic analyses of the sun, including the turbulent eddies on its surface, using the earlier Stratoscope 1 balloon system.

Total ANP Costs Incurred by Prime Contractors—FY1946-1961

(In thousands)

	Total	Operating Expenses Total	AEC	Air Force	Navy	Facilities and Equipment Total	AEC	Air Force
Development of the direct cycle nuclear propulsion system								
General Electric Co	$527,384	$462,867	$241,642	$219,670	$1,555	$64,517	$22,913	$41,604
Wright-Cheney-Birch	6,168					6,168	6,168	
Utah Construction Co	5,316					5,316	5,316	
Ralph M. Parsons Co	4,146	52	52			4,094	3,776	318
Phillips Petroleum Co	3,689	3,621	3,621			68	68	
Arrington Construction Co	3,245					3,245	3,245	
J. N. Wise & Sons, Inc	3,157					3,157	3,157	
W. R. Cohoon Construction Co.	1,045					1,045	1,045	
Others	8,614	1,413	1,413			7,201	6,736	465
Total, other than GE	35,380	5,086	5,086			30,294	29,511	783
Total	562,764	467,953	246,728	219,670	1,555	94,811	52,424	42,387
Development of the indirect cycle nuclear propulsion system								
Pratt & Whitney Aircraft Division of United Aircraft Corp	164,468	138,200	100,468	35,891	1,841	26,268	5,657	20,611
Bureau of Public Roads—access roads for Connecticut Aircraft Nuclear Engine Laboratory (CANEL)	464					464		464
Union Carbide Nuclear Co.—(Oak Ridge National Laboratory)	68,306	67,716	67,716			590	590	
Others	5,597	3,188	3,188			2,409	2,409	
Corps of Engineers—(CANEL) facilities:								
Dawson Construction Co., Inc	7,616					7,616		7,616
Lane Construction Corp.	7,102					7,102		7,102
Benjamin F. Shaw Co	4,935					4,935		4,935
John A. Volpe Construction Co., Inc.,	3,715					3,715		3,715
Perini Corp	2,209					2,209		2,209
Charles T. Main, Inc	1,787					1,787		1,787
McConathy, Hoffman & Associates	1,141					1,141		1,141
Corps of Engineers Charges	1,776					1,776		1,776
Others	11,232					11,232		11,232
Total, Corps of Engineers	41,513					41,513		41,513
Total	280,348	209,104	171,372	35,891	1,841	71,244	8,656	62,588
Airframe subsystem and component design, and related shielding and radiation effects studies								
Convair Division of General Dynamics Corp	70,312	63,860		60,922	2,938	6,452		6,452
Lockheed Aircraft Corp	33,694	19,224		19,224		14,470		14,470
The Glenn L. Martin Co	2,399	2,399			2,399			
Massachusetts Institute of Technology	2,390	2,390		2,390				
International Business Machines Corp	1,958	1,958		1,958				
Bendix Aviation Corp	1,650	1,650		1,650				
Boeing Aircraft Corp	1,600	1,600		1,600				
Republic Aviation Corp	1,562	1,562		1,562				
General Electric Co	1,475	1,475		1,475				
Western Electric Co., Inc	1,188	1,188		1,188				
Others	4,856	4,856		4,469	387			
Total	123,084	102,162		96,438	5,724	20,922		20,922
Studies relating to the feasibility of aircraft nuclear propulsion and general support								
Fairchild (NEPA project)	20,971	20,971		19,471	1,500			
Union Carbide Nuclear Co.—(Oak Ridge National Laboratory)	24,907	23,489	22,859	630		1,418	1,418	
Maxon Engineering Co	9,300					9,300		9,300
Ralph M. Parsons Co	1,455	413		413		1,042		1,042
Sylvania-Corning Nuclear Corp.	1,187	1,187	1,187					
Corps of Engineers Charges	552					552		552
Others	15,787	14,352	1,662	9,275	3,415	1,435	1,287	148
Total	74,159	60,412	25,708	29,789	4,915	13,747	2,705	11,042
Total costs, ANP program	$1,040,353	$839,631	$443,808	$381,788	$14,035	$200,724	$63,785	$136,939

Notes:

1. The costs shown on this schedule do not include (1) the costs of special nuclear materials expended and the value of special nuclear materials and special reactor materials at June 30, 1961, and (2) the administrative expenses of the Atomic Energy Commission and the Dept. of Defense incurred in connection with the overall management and administration of the manned ANP program.
2. The costs assigned to contractors include the cost of certain government furnished services, materials, facilities, and equipment assigned to the participating contractors including the book value of equipment and machinery furnished at no cost from the industrial reserve.

Total ANP Costs Incurred by AEC and DOD FY1946-1961

(In thousands)

	Total	1946-51	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961
Atomic Energy Commission:												
Direct cycle nuclear propulsion system	$299,152		$1,496	$12,628	$13,277	$12,121	$21,174	$41,385	$51,032	$55,674	$44,846	$41,617
Indirect cycle nuclear propulsion system	188,029	6,941	7,512	7,619	8,948	15,361	27,722	29,961	17,256	16,568	21,248	21,731
Feasibility studies and general support	28,413	484	17	484	1,665	2	516	8,702	4,614	4,118	3,889	5,742
Total, AEC	507,594	7,445	11,246	20,931	13,928	27,484	49,411	79,149	73,122	76,402	69,183	69,291
Department of Air Force:												
Direct cycle nuclear propulsion system	262,057	356	5,614	14,909	4,502	7,214	11,228	12,628	55,486	51,905	43,012	33,791
Indirect cycle nuclear propulsion system	98,478		917	2,330	2,058	3,425	10,365	17,612	16,791	4,491	7,466	10,809
Airframe subsystem and component design, and related shielding and radiation effects studies	117,360	125	958	5,574	5,117	5,861	15,736	25,813	23,071	16,166	16,379	8,358
Feasibility studies and general support	40,811	18,471	78	145	267	325	774	3,113	6,478	4,167	3,494	2,567
Total, Air Force	518,726	19,951	7,779	21,958	11,944	16,825	38,063	99,378	103,826	76,731	84,345	54,525
Department of Navy:												
Direct cycle nuclear propulsion program	1,555		590				223		822			
Indirect cycle nuclear propulsion system	1,841								105	262	1,474	
Airframe, subsystem and component design and related shielding and radiation effects studies	5,724			98	74	488	1,934	1,448	918	565	300	
Feasibility studies and general support	4,915	1,500		77	24	67	1,543	16	706	942		
Total, Navy	14,035	1,500	590	175	98	487	3,700	1,464	2,556	1,769	1,774	
Total costs of ANP Program	$1,040,355	$28,897	$19,525	$44,864	$35,970	$44,796	$91,194	$179,991	$179,504	$157,302	$115,302	$121,816

Note: The costs shown on this schedule do not include (1) the costs of special nuclear materials expended and the value of special nuclear materials and special reactor materials at June 30, 1961, and (2) the administrative expenses of the Atomic Energy Commission and the Department of Defense incurred in connection with the over-all management and administration of the manned ANP program.

Reorientations Hampered ANP Program

By Katherine Johnsen

Washington—Fifteen-year $1-billion aircraft nuclear propulsion program was doomed to failure by continual reviews and reorientations that kept it in a state of flux, according to a detailed report by General Accounting Office.

Feasibility studies on nuclear propulsion for aircraft started in 1946. The aircraft nuclear propulsion (ANP) program was launched in February, 1951, and canceled in March, 1961.

In its 190 page report GAO documented in detail the seven basic reorientations of ANP during its 10 year existence as a program—an average of more than one every 18 months.

GAO did not pass on the validity of the reorientations, which varied from a research program to an accelerated program to develop a weapon system for the Air Force—or on the question of whether ANP ever could have achieved its goal of a successful military system.

"Although it was outside our scope to examine into the reasonableness of or the justification for the frequent changes in the program objectives," GAO said, "we do not believe that a research and development effort of the complexity and magnitude of the aircraft nuclear propulsion program can reach its goal in an effective and efficient manner unless a certain degree of stability in objectives is accorded to the program."

In announcing cancellation of the program in a message to Congress in March, 1961, President Kennedy commented that "the possibility of achieving a militarily useful aircraft in the foreseeable future is still very remote." The cancellation, he added, will avoid a future expenditure of at least $1 billion, which would have been necessary to achieve first experimental flight."

During its lifetime ANP was in competition with missiles as a weapon system and in competition with missiles and numerous other advanced technology projects for Defense Dept. funds. "As a result, the importance attached to the ANP program varied greatly throughout its history," GAO said.

Responsibility for the reorientations was with Defense Dept. and the Air Force, which established the military requirement and set the direction for the program, co-sponsored by Atomic Energy Commission. GAO criticized Defense Dept. for repeatedly failing to give explicit and formal directions to AEC and contractors even after a reorientation had been decided upon.

In one early case cited by GAO, AEC waited over two years for a decision from Defense Dept. In December, 1948, after feasibility studies had been under way for two years, AEC formally asked Defense Dept. whether a nuclear-powered aircraft merited "expending heavily of the national wealth" for its development. Defense Dept. replied that a study was under way to determine the matter. In August 1949 Defense Dept. replied again that a decision had been deferred pending an other evaluation.

In December, 1950, AEC again asked DOD for a decision on the military worth of the nuclear powered aircraft as well as the urgency with which the Defense Dept. regards the proposed development program leading to the "flying laboratory in 1956."

In January, 1951, Defense Dept. replied that the Joint Chiefs of Staff "were currently considering the establishment of a requirement for the con-

struction of an aircraft nuclear powerplant suitable for the propulsion of aircraft.

The report said: "On Mar. 13, 1951—over two years after AEC initially requested a decision by Defense Dept.—the military liaison committee informed AEC that the Joint Chiefs of Staff had determined that 'a military requirement exists for the construction of a nuclear powerplant suitable for aircraft propulsion, with priority for accomplishment to be after any reactor projects primarily concerned with the production of fissionable materials.'" ANP was then launched.

In a later case detailed by GAO, Defense Dept. delayed eight months in giving guidance to AEC. This case started in July, 1959, when Defense Dept. notified AEC that ANP was to be reoriented from a development program for a weapon system for the Air Force to a research and development program leading toward major reactor experiments.

McCone's Reply

John A. McCone, then chairman of AEC, replied to Neil H. McElroy, then secretary of defense:

"I am deeply concerned that the commission has expended such extensive time and effort only to find that after we have achieved a capability of providing a nuclear system for flight there is no Defense Dept. requirement for this system. Since ANP is an extremely costly development, it seems only reasonable that if the Commission is to continue to support the Defense Dept. in this joint effort, specific Defense Dept. requirements must be provided in order that the Commission can establish proper nuclear criteria and parameters. It would, indeed, be deplorable if when we develop the next advanced reactor which could provide sustained nuclear flight it would evolve that there was no requirement for this reactor.

"In view of the above, the Commission requests that the Defense Dept. provide at the earliest practicable date firm ANP program requirements and/or objectives in sufficient detail to permit the Commission to properly and adequately cooperate in a joint program toward a common useful goal."

In September, 1959, Defense Dept. furnished AEC with interim guidance, which "stated that the objectives of both the direct and indirect cycle programs were to develop a powerplant which could be used to fly a plane at a speed of between Mach 0.8 and 0.9 at an altitude of about 35,000 ft. and which would have a potential life of about 1,000 hr.," according to GAO.

AEC promptly asked Defense Dept. for "clarification" as to whether it should move forward with two developments—the direct cycle powerplant and the indirect cycle powerplant—or only one.

Finally, in February, 1960—eight months after the reorientation was decided upon—AEC was told to put only one of the powerplants on a flight-stage basis, but to continue research on both approaches.

Defense Dept. generally agreed with findings of the GAO report on ANP. In a letter to GAO, Deputy Secretary of Defense Roswell Gilpatric said:

"We agree that the program suffered considerably from lack of prompt decisions and from frequent changes in emphasis and goals. It is for the purpose of minimizing the impact of such conditions in the future that we have instituted many new management procedures . . ."

In another letter, the office of Assistant Secretary of the Air Force for Research and Development Brockway McMillan explained:

"The problem with ANP was that the ultimate goal shifted in response to a balancing of periodic estimates of achievable technology against evaluations of Air Force operational requirements. As a consequence, the timing of ground test and flight test objectives also shifted. Obviously, such changes in emphasis and direction of the ANP program were considered appropriate and mandatory by the program management."

The two main ANP contractors—General Electric Co. and Pratt & Whitney Div. of United Aircraft Corp.—were paid fees totaling $25.5 million for this work, GAO said. This was an

ANP Facilities, Equipment Costs by Major Installation—FY 1946-1961

(In Thousands)

	Costs to June 30, 1961		
	Total	AEC	Air Force
Development of the Direct Cycle Nuclear Propulsion System:			
Evendale, Ohio:			
Air Force Plant No. 36 (operated by General Electric Co., Aircraft Nuclear Propulsion Dept.)	$45,718	$11,880	$33,838
General Electric Co. Plant (operated by Flight Propulsion Division)	7,778		7,778
Total—Evendale, Ohio	53,484	11,880	41,604
Idaho Falls, Idaho:			
National Reactor Testing Station (operated by GE ANP Dept.)	41,317	40,534	783
Total	94,811	52,424	42,387
Development of the Indirect Cycle Nuclear Propulsion System:			
Middletown, Conn.:			
Air Force Plant No. 82, Connecticut Aircraft Nuclear Engine Laboratory (CANEL)—(operated by Pratt & Whitney Aircraft)	67,825	5,237	62,588
Oak Ridge, Tenn.:			
Oak Ridge National Laboratory (operated by Union Carbide Nuclear Co.)	1,636	1,636	.....
Idaho Falls, Idaho:			
National Reactor Testing Station (design costs for facility to be operated by Pratt & Whitney)	1,783	1,783	.....
Total	71,244	8,656	62,588
Airframe, Subsystem and Component Design Studies, and Related Shielding and Radiation Effects Studies:			
Ft. Worth, Tex.:			
Air Force Plant No. 4, Nuclear Aircraft Research Facility (NARF) (operated by Convair Division of General Dynamics)	6,452	.....	6,452
Dawsonville, Ga.:			
Air Force Plant No. 67, Georgia Nuclear Laboratory (GNL) (operated by Lockheed Aircraft Corp.)	14,470	.....	14,470
Total	20,922	.....	20,922
Studies relating to the feasibility of Aircraft Nuclear Propulsion and General Support:			
Wright Patterson AFB, Dayton, Ohio:			
Nuclear Engineering Test Facility (operated by the Air Force, Wright Air Development Division)	11,042	.....	11,042
Oak Ridge, Tenn.:			
Oak Ridge National Laboratory (operated by Union Carbide Nuclear Co.)	2,705	2,705	
Total	13,747	2,705	11,042
Total facilities and equipment costs	$200,724	$63,785	$136,938

average 5.3% profit on work totaling $481 million. The total was divided: GE, $20.5 million; Pratt & Whitney, $5 million. GE worked on the direct cycle and Pratt & Whitney on the indirect cycle powerplant.

Profits on Air Force contracts averaged 7%, or almost double the 3.6% for AEC contracts. This put AEC in a poor bargaining position and was a further cause of substantial delays in the ANP program, according to GAO.

In one instance cited by GAO, Pratt & Whitney's attempts to get Air Force terms incorporated in the AEC contract contributed to a 14-month delay in AEC's initial support of the indirect cycle propulsion system. Assistant Secretary McMillan's office made these comments to GAO on this situation:

"Relative to the fee difference between the Air Force and the AEC, the ANP contracts were negotiated by both agencies in conformance with established contractual policies and criteria. Air Force fees were within the boundaries allowed by the Armed Services Procurement Regulations. They compared favorably with those allowed other contractors for research and development programs of comparable complexity."

GAO urged that in the future, single contracts be let to each contractor under programs sponsored by two or more government agencies.

Although ANP never achieved its goal, it did provide "a tremendous acceleration in the advancement of nuclear reactor technology" and made invaluable contributions to the space program, according to AEC.

AEC Report

In a report requested by GAO and included in GAO's own report, AEC itemized 20 "major known contributions" stemming from ANP work by Union Carbide Nuclear Co. at the Oak Ridge National Laboratory, from indirect cycle work by Pratt & Whitney and from direct cycle work by GE.

"It is not possible to inventory, realistically, the total benefits derived from the program," AEC added. "It is clear that by the very nature of the program the technology produced was and is a very important asset."

AEC noted major outgrowths:

- **ANP circulating fuel** reactor program at Oak Ridge has led to the molten salt reactor program for civilian power presently under way there.
- **Indirect cycle program** resulted in the development of extensive liquid metal technology, recently directed to the development of an advanced high temperature lithium-cooled reactor system.

Information from ANP on high temperature materials and radiation shielding particularly has been of great value to the space program, AEC said.

AEC explained why ANP had been successful in advancing technology:

"A nuclear jet propulsion system for aircraft application requires the minimizing of size and weight and the maximizing of power-heat-output. This problem is further increased in difficulty by the necessity of providing adequate nuclear shielding. Power output is derived from the heat produced by the reactor, hence the requirement for a reactor which produces extremely high temperatures while at the same time minimizing size and weight. The ANP program was, therefore, starting at the upper limits of nuclear technology which required many so-called 'breakthroughs' in materials, reactor concepts, instrumentation, shielding and controls. These circumstances automatically provided a tremendous acceleration in the advancement of nuclear reactor technology."

ANP Reviews

GAO counted 13 broad reviews of ANP to evaluate past accomplishments and set future objectives during the last six years of the program. This meant that ANP was reviewed an average of more than twice a year to decide whether the program should be reoriented.

Of the 13 reviews, seven were by Air Force, five by Defense Dept., and one by AEC. GAO found that:

- "The frequent reviews of the ANP program were made by temporary groups.
- **The reviews were based** on brief visits to the contractors' plants and briefings and discussions in Washington.
- **"Little continuity** in membership could be found among the review groups."

Since these reviews were intended generally, to evaluate results accomplished and to provide advice to top management on direction of effort, it appears that a permanent review group comprised of appropriate Defense Dept. and AEC representatives with some continuity in membership would have been more efficient and effective and would have been more in keeping with the joint project concept . . ." GAO said.

Shortly after ANP was launched early in 1951, four Air Force contracts and one AEC contract were let. Both USAF and AEC let contracts to General Electric to work on a propulsion system. Air Force also contracted with Convair Div. of General Dynamics Corp. for modification of its B-36 aircraft, Lockheed Aircraft Corp., for design of a series of airframes and Pratt & Whitney for work on the supercritical water reactor.

By November, 1951, General Electric estimated that it could deliver the first powerplant to Convair by about May, 1956, at cost of about $188 million.

Highlights of the eight different ANP programs reported by GAO:

- **Flight demonstration program.** This lasted 13 months, from April, 1952, to May, 1953. The program proposed by the Air Force to flight test a nuclear propulsion system in a flying testbed in 1956-57 was accepted by AEC with reservations as to its technical feasibility and financing. Within a year three events led to a drastic program cutback.

In March, 1953, an ad hoc committee of the Air Force Scientific Advisory Board—consultant body to the USAF Chief of Staff—recommended a 50% cutback in ANP as "unwarranted by the state of the art and the rate of progress."

In April 1953, President Eisenhower asked Defense Dept. and AEC to work out a definitive program to reduce expenditures for ANP for Fiscal 1954 and 1955. The Eisenhower Administration's economy program was moving into full swing.

Also in April, the National Security Council recommended elimination of ANP "as not required from the viewpoint of national security."

The outcome was that work at General Electric was reduced to a minimum development program and all work on the nuclear-powered X-6 aircraft at Convair was canceled. Work was stopped on the GE reactor for use in a ground test powerplant.

- **Applied research and component** development program. This lasted 18 months—from May, 1953, to November, 1954. The net effect of this program was to postpone indefinitely the ground and flight testing of a nuclear-powered aircraft.

General Electric's work was redirected toward applied research and component development of an advanced direct cycle reactor concept based upon a new configuration and a more promising type of fuel element.

In May, 1953, the Navy initiated active participation in ANP with study contracts for a seaplane.

Air Force opposed the deceleration and in April, 1954, the Air Force Council said that, "... there was an urgent military requirement for the achievement of an aircraft nuclear propulsion operational capability at the earliest possible date. ..."

At this point, the Office of Nuclear Propulsion—the joint AEC-USAF agency—said that a nuclear-powered aircraft could be operational by 1960.

- **Weapon System 125A program.** This lasted 25 months—from November, 1954, to December, 1956.

The major objective during this period was to fulfill an official Air Force requirement for a nuclear-powered airplane with supersonic capability. USAF awarded Convair and Lockheed contracts for studies and investigations of a nuclear-powered strategic bombardment weapon system.

In March 1955, Air Force issued a requirement for a nuclear-powered, piloted bombardment weapon system, to be operational during 1963. It was to be capable of delivering nuclear weapons against any target in the world. The primary mission would be to take off from bases deep within the continental U. S., proceed by circuitous routes to a target located anywhere in the world, bomb the target, and return to the base of departure, again using circuitous routes, if desirable. The minimum cruise speed was to be Mach 0.9 and it was to have the maximum possible supersonic dash speed.

A Defense Dept. review group, at the time Air Force issued this requirement, was optimistic as to ANP success.

Also at this time, the Navy issued an operational requirement for nuclear-powered seaplanes of high subsonic capability for long-range attack, minelaying, and reconnaissance.

A few months later, in June, 1955, Defense Dept. and AEC agreed to accelerate ANP and set 1959 as the objective for testing a prototype propulsion plant. General Electric established target dates calling for flight testing

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A scalene triangle ABC which is not a right triangle has sides which are integers. If $\sin A = \frac{5}{13}$, find the smallest values for its sides, i.e., those values which make the perimeter a minimum.

—Contributed

ANSWER TO LAST WEEK'S PROBLEM. $x^3 + y^3 = 12(x + y)$ or $x^2 - xy + y^2 = 12$, $x^2 - 2xy + y^2 = 12 - xy$, $(x - y)^2 = 12 - xy \geq 0$. If $x \leq y$ then $12 \geq x^2$ and $x = 1, 2, 3$. The only integral solution is $x = 2$, $y = 4$.

of its engine during July-December, 1960, and the production of militarily useful powerplants by 1963.

General Electric was teamed with Convair for the airframe and Pratt & Whitney was teamed with Lockheed in October, 1955.

By late 1956, in the midst of this accelerated activity, a panel of the Air Force Scientific Advisory Board cautioned that "while the present state of the reactor art is encouraging, it does not conclusively demonstrate that a useful vehicle can be built."

In December, 1956, the assistant secretary of defense for research and development, then Dr. Clifford C. Furnas, advised the secretary of defense, then Charles E. Wilson:

"For some time there has been a growing concern from both technical and fiscal aspects that the ANP program must be substantially reoriented."

The Weapon System 125-A program was canceled by the President a few days later.

• **Experimental program—no flight objectives.** This lasted two months from January to March, 1957. GAO described this period as "one of uncertainty."

In February, the Joint Congressional Committee on Atomic Energy called for a definite objective and a sense of organized planning beyond Fiscal 1958.

• **Experimental development program—flight objectives.** This lasted ten months—from April, 1957, to February, 1958.

The objectives were vague and the program was not fully geared toward flight until near the end of the period.

In December, 1957, the Air Force secretary, then James H. Douglas, urged an acceleration of ANP. In a letter to the deputy secretary of defense, then Donald A. Quarles, he urged that "the Dept. of Defense strongly recommend to the President that approval be given to accelerate the Air Force ANP program leading to early nuclear flight in a KC-135 or similar type aircraft. . . ."

An ad hoc panel appointed by DOD disapproved the acceleration.

After a meeting with Defense Dept. and AEC officials, the President in February, 1958, ruled that USAF's proposed accelerated flight program would detract from the goal of achieving militarily useful aircraft, and disapproved.

• **Development program—flight objective in militarily useful aircraft.** This program lasted seven months—from March, 1958, to October, 1958.

GAO saw little real meaning in redirecting a program from a flight objective to a flight objective in militarily useful aircraft.

The reorientation ordered by the President, which puzzled GAO, was explained like this at the time by Aircraft Nuclear Propulsion Office:

"The objective of the ANP program is the early achievement of an operational military aircraft as opposed to an early nuclear flight demonstration having no military utility. Notwithstanding the importance of both of these objectives, they were believed to be conflicting. . . ."

At the same time—March, 1958—the President said in a letter to the Joint Congressional Atomic Energy Committee that military utility had always been an ANP objective. He stated:

"The development of a nuclear propelled aircraft capable of military missions has always been the prime goal of this program. . . ."

General Electric was advised that the objective of the new program was "the earliest possible achievement of a prototype propulsion system for application to a low-level subsonic mission."

• **CAMAL program.** This was a development program for a continuously airborne missile-launcher and low-level weapon system (AW Dec. 19, 1959, p. 56). It lasted nine months, from October, 1958, to July, 1959.

The target date for demonstration of the performance of the airplane, equipped and propelled by the prototype nuclear system, was 1962. The target date for the weapon system to be operational in SAC was 1966.

The basic difference between CAMAL and Weapon System 125-A was that the 125-A requirement specified supersonic speeds at high altitudes while CAMAL specified subsonic speeds and emphasized very low altitude bombing attack capability.

General Electric was directed in November, 1958, to initiate nuclear ground testing of the prototype propulsion system in 1960 and initiate flight development testing in 1962.

After reviewing USAF's proposed budget for Fiscal 1960, Defense Dept. canceled flight testing and restricted the program to reactor development.

In February, 1959, the Joint Congressional Atomic Energy Committee reported that ". . . we find this almost incredible situation:

"The program still has no firm set of objectives. . . .

"No decision has been made regarding actual nuclear flight and no target dates have been set for such flight.

"Recommendations of the project director as to funding levels required to get the job done have been virtually ignored. . . .

"The annual expenditure of $150 million for the ANP program as a holding operation to avoid difficult technical and administrative decisions which must be made to lend clearcut direction to the program is a completely indefensible use of the taxpayers' money. . . ."

In March, 1959, Air Force selected Convair, in a competition with Lockheed, to work with GE in the initial design of a bomber prototype.

In June, 1959, the Joint Chiefs of Staff, then headed by USAF Gen. Nathan F. Twining, reported to the secretary of defense that "there is considerable military potential in the nuclear-powered aircraft," but stated that they were unable to establish a military requirement for it or to define the specific weapon system for which it would be used. The JCS urged expansion of the program to include a flight objective as soon as possible.

• **Research and development program—with primary emphasis on high performance reactors.** This lingered on for 20 months, from July, 1959.

The work on the direct and indirect cycles during this period was directed toward major reactor experiments in 1962-63. After these experiments, presumably one of the cycles was to be selected for further development and continued through to flight test.

The reorientation from CAMAL was initiated by a Defense Dept. decision rejecting proposals for early flight test of GE's direct cycle powerplant.

Gen. Thomas D. White, then USAF chief of staff, AEC Chairman McCone, and others opposed this decision at congressional hearings. These proponents of the early flight concept pointed out that historically, aviation development has occurred on a step-by-step basis, and that to begin with, prototype aircraft always have limited performance.

Defense Dept. opposed this approach at the hearings.

After a review in November, 1959, ALC decided that neither the direct cycle nor the indirect cycle had reached a stage of development where it could be preferentially selected with any degree of technical confidence.

The final Eisenhower budget, submitted to Congress in January, 1961, drastically cut the allocation for ANP and explained that the lower funding was possible because work was to continue on only one propulsion system (AW Jan. 23, 1961, p. 28). It did not specify whether this was to be the direct or indirect cycle.

ANP was eliminated in the new Kennedy Administration's revisions to the fiscal 1962 budget proposed by the outgoing Eisenhower Administration (AW Apr. 3, 1961, p. 26).

Navy Calls for Integrated VAX Avionics

By Philip J. Klass

Washington — Navy's requirements for an integrated avionics system for light-attack aircraft, suitable for the proposed new VAX joint-service airplane, if its development is authorized, were disclosed here late last week to approximately 30 potential bidders. These bidders are expected to attend a pre-bid briefing conference on the major development program.

The system, which is to make maximum use of semiconductor microcircuits, will include bombing/navigation radar, a central digital computer, inertial/Doppler navigator, Tacan, communications and identification equipment, as well as cockpit instrumentation. It will be one of the most complex airborne avionics system developments ever sponsored by Bureau of Weapons' Avionics Div.

Requests for proposals are expected to be issued shortly with bids due in time to permit contractor selection and contract negotiation by June 30. The program is expected to attract many bidders because of its scope and potential size.

BuWeps Emphasis

While the widespread use of microcircuitry is expected to result in significant savings in size, weight and power consumption, important factors in a light attack airplane, BuWeps officials place far more emphasis on expected improvements in reliability, maintainability and overall serviceability. These factors are expected to be extremely influential in selecting the winning proposal, AVIATION WEEK & SPACE TECHNOLOGY was told.

The new integrated system is to have built-in automatic fault detection and location provisions to enable maintenance personnel to isolate the trouble to a small, easily replaced module or device without use of external test equipment wherever possible. Current thinking is that the digital computer used during flight to provide navigation and control functions will be used on the ground for this checkout and trouble-shooting function. This is a technique pioneered by North American's Autonetics Div. in the Hound Dog and Minuteman missiles (AW Oct. 29, p. 57).

Navy plans to adopt a "throw-away maintenance" philosophy of discarding small devices or modules where the cost of shipping such items to overhaul depots and repairing them exceeds the cost of buying new spares. Avionics Div. officials do not spell out the maximum size or cost of such "throw-away" units but instead have asked each bidder to recommend the optimum-size package for its own design configuration.

The widespread use of microcircuits—unrepairable for all practical purposes—in the integrated avionics system assures that a semiconductor microcircuit crystal or thin-film substrate will be at least the minimum size throw-away package and perhaps the optimum size will be a cluster of such elements.

An important factor in rating contractor proposals is expected to be the ingenuity evidenced in the equipment organization and layout to facilitate trouble-shooting and replacement of defective units.

Development Categories

Last fall BuWeps Avionics Div. announced plans to categorize future equipment developments by one of three type numbers, depending upon the maturity of equipment currently in use and the extent to which it meets Navy's needs. This is intended to indicate to bidders where the Navy felt emphasis should be placed in the new development.

For example, Type 1 was applied where existing equipment represented 80% or better of the achievable ultimate and where major emphasis was desired on improving reliability and maintainability. Type 2 represented 50-80% of the ultimate in performance, requiring equal emphasis in the new design on both improved performance and increased reliability and maintainability. Type 3 developments were those where current performance is less than 50% of the ultimate and where principal emphasis must be placed on improving such performance (AW Oct. 8, p. 110).

With the exception of a few Type 3 items, the new integrated avionics system will represent about equal proportions of Type 1 and Type 2 equipments, according to an Avionics Div. spokesman, permitting heavy emphasis on improved reliability and maintainability.

Early results from BuWeps program to substitute microcircuitry for conventional discrete miniature component circuits in existing avionic equipment indicates that microcircuitry is living up to its proponents' predictions of greater reliability.

Qualification Tests

In side-by-side qualification tests of the original conventional component plug-in cards and new replacement cards that use semiconductor microcircuits, the latter have shown a mean-time-between-failure (MTBF) which is 2½ times longer than the conventional construction, according to a Navy spokesman. These results are based on a total of one million microcircuit test hours, giving a 60% confidence limit. With later versions of the microcircuits this advantage may rise to 10:1, he adds.

Bureau of Naval Weapons shortly will issue requests for industry proposals for a similar, but less complex, integrated avionics system for use on the new CH-53A (Sikorsky) transport helicopter. Approximately 50 companies have indicated a possible interest in bidding for the program.

The integrated helicopter avionics system will include navigation, terrain avoidance equipment and cockpit instrumentation.

Conventional off-the-shelf communications equipment will be supplied separately. Navy has asked companies to use microcircuitry wherever they can without delaying aircraft production requirements.

Microcircuit Briefing

Washington—Two-day symposium in which both microcircuit and avionic equipment manufacturers will brief government and industry representatives on procedures developed for introducing the technology into new designs will be held Apr. 25-26 at the Dept. of Interior auditorium in Washington under the sponsorship of the Avionics Div. of the Bureau of Naval Weapons.

First day of the conference will be devoted to reports by Navy equipment manufacturers on their experience in converting to microcircuitry. Second day will include reports by microcircuit manufacturers on procedures for providing close coordination between equipment and microcircuit designers.

Companies interested in attending the conference should write to Bureau of Naval Weapons, Washington 25, D.C., Attention: RAAV-11.

FILTER CENTER

▶ **Bell System Tests Thin-Film Microcircuits**—Deposited tantalum thin-film passive microcircuitry currently is being evaluated in field trials by American Telephone & Telegraph Co. as forerunner to its introduction into the system. Total of 500 modulator pads, each containing 10 resistors ranging in value from 65 to 5,000 ohms and two P.02 microfarad capacitors, are involved in the test.

▶ **Boeing 727 Connections**—Approximately 1,600 individual electrical connectors will be used in each Boeing 727 jetliner, largest number ever used in a single aircraft, according to Amphenol Borg Electronics Corp., which is supplying them under a $1.3 million contract with Boeing.

▶ **High-Resolution Photos Relayed**—Fine detailed aerial photographs have been successfully transmitted by radio link to the ground by a Navy Crusader reconnaissance plane from 70 mm. film exposed only a few moments earlier during tests conducted by Naval Air Development Center, Johnsville, Pa. The Photoscan System used in tests, developed by CBS Laboratories, is a prototype of more advanced equipment now under development which opens the way to drone reconnaissance missions, the company says.

GE Interconnection

Low-cost interconnection for opposite sides of printed circuit board uses tinned copper pins instead of eyelets or plate-through connections with saving of 30-75%. The technique developed by General Electric, uses 0.045 in. dia. pin which is inserted by specially developed machine into 0.040 in. dia. hole in board at rate of 30/min. Pin is then soldered to each side of the board.

▶ **Electronic Exports Increase**—During the first nine months of 1962, U.S. exported $556.1 million in electronic products, an increase of 27% over the $437.5 million for the same period in 1961, according to Commerce Dept.'s Business and Defense Services Administration. Largest increase was in electronic detection and navigation equipment, which totaled $122.7 million, an increase of 180%. Electronic computer exports were $99.1 million, an increase of 25% over previous year.

▶ **DESC Assumes Major Load**—Defense Electronic Supply Center, Dayton has assumed management responsibility for 372,000 types of component spare parts formerly handled by Air Force. The agency is responsible for buying and supplying standard electronic spare parts for all military services. To date DESC has assumed responsibility for resistors, connectors, capacitors, coils, transformers, filters and networks, electron tubes and semiconductors. Transfer of remaining items from Army and Navy is scheduled to take place by June, 1964.

▶ **Navy ASW Studies Progress**—First phase of an underwater acoustics research program to study deep-water transmission of sound across the Atlantic Ocean, to improve submarine detection and underwater communication systems, has been completed by Naval Ordnance Laboratory. Program is investigating natural sound channel in which waves are confined by interacting effects of water temperature and density, providing relatively little signal attenuation.

▶ **Laser Detector-Converter Developed**—"Lasecom," a combination photo tube and traveling wave tube suitable for detection and demodulation of a laser beam, with a bandwidth of 1,000 mc., has been developed by Radio Corp. of America. Prototype model operating at L-band, first shown at recent Institute of Electrical and Electronic Engineers Convention in New York, measures 18 in. long and weighs 5 lb. Basic tube design developed under Army sponsorship is adaptable also to S-band, C-band and X-band, RCA reports.

▶ **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

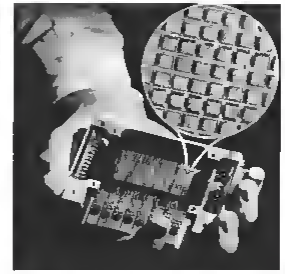
• **Sperry Rand's Univac Div., Philadelphia**, will develop reliable, low-power thin-film memory for spacecraft computer use, with capacity of 100,000 bits and total power requirement of 133 milliwatts, under contract from Goddard Space Flight Center. Memory, including power supply, ultimately is expected to occupy 70 cu. in. and weigh less than 4 lb. Univac Div. in St. Paul has received Navy Bureau of Ships contract for $4.4 million to develop advanced computer design digital weapons assignment equipment and conduct research on smaller thin-film packages for more rapid data processing.

• **ITT Federal Laboratories, Nutley, N. J.**, $4.5 million award from Navy Bureau of Ships to develop and manufacture improved solid-state Tacan shipboard facility, the AN/URN-20, including test and monitor equipment.

• **Sylvania Electric Products** will investigate detailed structure of the ionosphere and its effect on communications under $200,000 contract from Navy Bureau of Ships.

• **Hazeltine Corp., Little Neck, N. Y.**, will develop and produce new "minibuoy," a miniature sonobuoy measuring only 3 in. in diameter and 21 in. long to be dropped from ASW aircraft. The new AN/SSQ-42 will permit selection of the depth to which its hydrophone is dropped to detect underwater sounds.

• **Walkins-Johnson Co., Palo Alto, Calif.**, has a $2.5 million contract from Army to develop, build and test a traveling wave tube suitable for use in a military communications satellite.



Magnetic Memory

High-density magnetic memory developed by Bell Telephone Laboratories has storage density of 1,100 bits per square inch, read-write time as short as 0.2 microseconds and requires low power. New memory device resembles miniature waffle iron, consisting of base plate of high permeability ferrite which has grid of slots cut into its surface. Pre-printed wiring pattern, one set for read-write and one set for digit sensing, is placed in slots and overlayed with a square loop magnetic material. Information is stored in the overlay material between the posts in the direction of magnetization of the magnetic film. Typical waffle-iron memory has posts 0.1 in. long, 0.03 in. wide and a slot width of 0.03 in. Memory can have either destructive or non-destructive read-out depending on whether single or two magnetic overlay materials are used. Device shown can store 64 words of 30-bits each.

APOLLO MIDCOURSE NAVIGATION simulator is being used to investigate problems associated with determining spacecraft position during transit to the moon, making gradual corrections in trajectory to assure arrival at desired destination. Simulator cab tests on air bearing and will carry three men seated before an airborne computer control panel. Tests are conducted by NASA's Ames Research Center

Apollo Navigation Simulator Tests Begin

Moffett Field, Calif.—Tests are getting under way here on a navigation simulator intended to explore problems of Apollo spacecraft navigation during the translunar phase of its trip to the moon (AW July 2, p. 265).

Simulator which is a representative layout of the Apollo command module, will help to determine possible requirements for navigating in space. It will be used in seeking answers to questions relating to midcourse corrections in the spacecraft trajectory and exploring facets of crew performance—how to effectively use the crew, what will be the optimum allocation of functions among the crew and instrumentation systems, what types of sextants (for determining position in space) provide best compromise between accuracy and simplicity.

While the vehicle's course in actual flight will be determined by an inertial navigation system, the actual spacecraft trajectory will deviate to some degree from the intended one. This will require that the spacecraft crew navigation instrumentation system combination determine its position in space, compare this with its intended position and trajectory and then make changes in spacecraft velocity so that the actual point at which it arrives near the moon (about 20,000-km. altitude) will correspond with the initially intended aimpoint. To make the change immediately, rather than gradually correct the trajectory, would require too great an expenditure of fuel—more than the approximately 300 fps. velocity increment thought to be available for this purpose.

Once on its lunar trajectory, the crew-system will take a number of fixes on predetermined stars, measuring the angles from the spacecraft between the limb (tangent) of the earth and the stars. A single star sighting gives a cone of points, so that three points are necessary to determine position. Perhaps six or more readings will be made within a 30-min. period and these would be fed to an on-board digital computer which will estimate position by a statistical process, estimate velocity and predict probable errors by comparing these with the intended trajectory. The computer calculates necessary velocity increments to be provided by spacecraft propulsion, time that thrust should be applied to bring the spacecraft onto its new trajectory. The crew-navigation instrumentation system will have to determine vehicle position to within a three sigma accuracy of 10 sec. of arc.

Simulator has capacity for three men who will function in a shirt-sleeve environment so that they are not unduly stressed. Initially, attitude of the cab will be controlled by reaction jets. Since it is subject to a 1g field, disturbing torques are set up that degrade the balance of the cab. This requires, in the first simulator version, that the center of rotation and the center of mass coincide. Ames plans to alter this later so that a servo system will drive the cab in roll, pitch and yaw.

For the tests an IBM 7090 situated elsewhere at the center will perform functions of the on-board computer.

Approximately 40 ft. in front of the cab is a simulated star field with uncollimated lights representing stars on which fixes will be made. Difficult problem is presented by the relatively short distance between cab and star field so that even head motions create sizable angular differences in simulated stars.

FOAM INSULATION is sprayed onto interior of Minuteman transporter-erector (left). Approximately 3,000 lb of polyurethane are used on each container. Trimmer, mounted on special jig (right) takes a 6-in. cut of excess material off hardened insulation. Jig is moved down container interior on V-shaped rails near floor.

Minuteman Carrier Insulation Sprayed

Wichita, Kan.—Spray-gun application of polyurethane foam to insulate the interior of USAF-Boeing Minuteman ICBM transporter-erector vehicles has been developed here by Cessna Aircraft Co. This replaces an earlier system of attaching fabric-covered glass-fiber blankets, a time- and space-consuming process.

Insulation is an important requirement to aid environmental control systems installed in the transporter-erector. To protect the Minuteman's solid-propellant rocket motors and electronic guidance and control systems against extremes of ambient temperatures during transport to silos, the insulation permits maintenance of 80F interior temperature ±16 deg., although outside temperature may vary from 115F to −30F. Humidity can be controlled to 57%.

Original application method for the foam insulation was to set wooden forms inside the transporter-erectors, pour the foam in, let it harden and rotate the missile container to provide complete coverage. This method also proved impractical because of time involved.

Cessna studied the possibility of spraying the foam on the insides of the containers. A check of commercial trailer manufacturers revealed no experience that could be useful and the company had to develop its own methods by trial and error.

Excessive nozzle pressure of early spray-guns caused the material to shift, build up unevenly and sag during successive passes. These guns developed a nozzle pressure of approximately 90-110 psi. Cessna finally obtained guns that would provide the necessary 90-psi pressure in the spray head for proper mixture of foam material and air and expel it at approximately 30-40 psi.

Process involves first washing interior of the transporter-erectors with soap and water. Interior is then foam-sprayed; each pass of the gun applying approximately a 1-in. thickness of polyurethane foam. Successive passes can be made 30-40 sec. apart. Approximately 2,500-3,000 lb. of foam insulation is applied.

After spraying, the material is trimmed down to thickness varying from 3 in. to approximately .010 in. This is done in three steps. First a specially built jig carrying a 6-in. wide, air-driven cutting tool is moved along rails used to slide the missile in the transporter. This rough cut of excess foam is smoothed by hand trimming and finally by hand sanding.

After foam coating is finished, the lower half and flooring of the container receives a brush-applied coating of polyester resin. A glass-fiber cloth is applied to this, using staplers to tack it down smoothly. Another coating of resin is applied after the glass-fiber cloth is installed. A Hypalon protective coating is applied to the remaining portions of the transporter interior with rollers.

Container portion of the transporter-erector is about 8 x 8 x 65 ft., weighs slightly over 10,000 lb.

Cessna initially built only the container portion of the transporter-erector system for Boeing, but has since been made prime contractor for the entire 108,000 lb. system. This responsibility includes final assembly of all components and checkout before delivery. Tractor and trailer components are obtained from General Motors' Truck & Coach Div. container erection and missile hoist mechanisms are provided by Bendix-Pacific.

Cessna's current Minuteman contract covers delivery of transporter-erectors through July. Cessna has discussed follow-on orders and prices for vehicles as far as Wing 7, but no agreements have been reached.

Container design and fabrication required considerable use of airframe building techniques to maintain weight limitations imposed by highway load requirements and air-transportability payload restraints. An investigation of commercial trailer construction indicated that such procedures would result in a container considerably overweight and unable to accommodate weights and bending moments.

Cessna engineers went to a monocoque structure with aluminum alloy bulkheads and sides, top skins and stringers of magnesium. Close tolerance holes and bolts are utilized in high load areas just as with high performance aircraft.

Design technique closely resembled aircraft procedures. Since it was impossible to pinpoint precisely the loads and stresses that such a large structure would undergo, Cessna engineers purposely under-designed the structure by 10-20%, then checked out the high load critical points in actual static testing, "beefing up" as needed.

This provided a container designed to realistic conditions. Cessna engineers believe that the amount of beef up material added to the structure based on static testing results, was only 2% of what would have been required if the container had been estimated on paper.

As an indication of how seriously weight was considered, the company's engineers put in four months on a weight recovery design program to delete approximately 1,000 lb. Cessna's Minuteman project engineer Webb Moon said:

Checkout procedure includes erecting the container inside a recently built Cessna test fixture, putting a load of more than 110,000 lb. on the unit to give it a "permanent set" on its mount, checking operation of the missile hoist system with a 1,000 lb. weight attached, and a plumb-bob test to check alignment of the hoist and container.

Plumb-bob test is conducted with a load of 75,000 lb. pulled on the transporter-erector container. Test requirement calls for the plumb to have a maximum deviation of ¾ in. off center when it touches the ground. In actual lowering of a Minuteman missile from the transporter to the bottom of its silo, the missile must touch down only 2 in. maximum from the silo centerline.

Cessna erection checkout procedure requires a minimum of three cycles of the system. Total Cessna contracts to date for the transporter-erector call for approximately 25 units.

TRANSPORTER-ERECTOR is positioned at silo to lower Minuteman. Entire system, including 270-hp. GMC trailer tractor, is air transportable to airfield near missile site.

Beech Parts, Supplies Distribution Grows

By Erwin J. Bulban

Wichita, Kan.—Increase in the number of parts, accessories and supplies now bearing the Beech Aircraft Corp. trademark rather than the insignia of the manufacturer typifies the change taking place in vendor-airframe manufacturer relationships in the business aircraft industry.

Beech now inventories and distributes over 400 items from 50 suppliers under the Beech label, ranging from plastic-packaged washers to complete autopilots costing $10,000. This stock represents more than a $1.6 million inventory. About 90% of all instruments installed in its aircraft at the factory carry the airframe manufacturer's trademark rather than the original manufacturer's label. Last year alone, the airframe builder added 138 Beech label items to its inventories.

Indications are that the company will market, under its own label, a complete range of navigation and communications equipment, radars and transponders, in various price categories. The goal is to provide accessories, parts and supplies for the entire Beech line. This may even be extended to engines.

Prime reasons the company gives for this major extension of its airframe production activities include:

- **Big market** for accessories, parts and supplies. In Fiscal 1963 Beech expects to do better than $5 million in sales of such items, out of a total of some $45 million in commercial aircraft sales. This would represent an increase of better than $1 million over sales of accessories, parts and supplies last year.
- **Feeling that company has a vested interest** in backing all components of the aircraft with its own reputation and label, because customer places overall responsibility on the airframe manufacturer.
- **Provide better service** in some cases than can the original vendor. Large Beech factory inventory is geared to shipping 80% of all orders received within eight hours and aim is to handle 95% of all requests within 24 hr.
- **Electronic data processing** of factory inventory will be extended to take in all Beech distributor and dealer parts inventories, keeping track of items by brand and part number. This is now being done by the company on a test basis with one of its distributors. Eventually, this over all constant electronic scrutiny of all accessories, parts and supplies inventories at all distributors and dealers will not only supplement their own records and aid in keeping the logistics pipelines properly filled, but will permit plotting of movement of items throughout the country and evaluation of trends which can aid in spotting weak movements due to lack of sales effort, or market saturation.
- **Analysis of field consumption** of accessories, parts and supplies inventories can also aid in plotting growth pattern of service facility that is needed to keep up with the trend. Travel habits which can be analyzed to determine prime locations for future new service facilities also will be studied.

Indications are that entry into the accessories, parts and supplies market by the airframe manufacturers led to considerable opposition from vendors initially on the basis that supply of their equipment under another label would cause a loss of identity and loss of business for their own retail outlets. Three years ago it was difficult to persuade suppliers to even talk about the program. Now they beat a path to the airframe manufacturer's door, according to Beech parts and service operations manager Paul Allen.

Beech taps any of the company's engineering and laboratory facilities necessary to completely analyze the product and also gives it flight and service suitability tests. Each step of the process has to be checked off by the department supervisor responsible for the test, otherwise the evaluation stops there.

Three-quarters of the items submitted to Beech fail to get passing grades, Allen noted. And even after an item has been accepted for the Beech label, it is reviewed annually on the basis of the past year's record of sales acceptance and reliability based on service. Allen's department tabulates all customer complaints and warranty claims on vendor-supplied items.

A Beech corrective action committee then reviews all unsatisfactory reports and warranty claims and the department responsible for that portion of the original check-off must see that the vendor takes corrective action. If this doesn't happen, the item comes off the Beech trade name inventory.

This type of analysis of parts, accessories and supplies on the basis of actual field experience is something that would be extremely difficult or costly for most vendors to accomplish, since only the airframe manufacturer keeps such a detailed record of service experience on such a large fleet of aircraft. So generally, the fact that the airframe builder picks up these complaints and passes them along to the vendor is appreciated, since it provides excellent input for product improvement. The process also helps provide vendors with new product research information.

APPROXIMATELY 90% of instruments installed at Beech factory now bear Beech's name. Last year, the airframe manufacturer added 138 Beech label items to its inventories.

PRIVATE LINES

National Park Service, Federal Aviation Agency and State of North Carolina have announced plans for an airport at Kill Devil Hill, Kitty Hawk, N. C. Facility will have a 3,000-ft. paved runway, parking area and service facilities. Airport will be manned by personnel from the Kill Devil Hill museum. Airport is expected to open Dec. 17, 60th anniversary of the Wrights' first flight there.

International civilian air show, planned for September, 1964, in Los Angeles, has been sanctioned by the National Aeronautic Assn. Aerobatic, parachuting, racing, ballooning and gliding competitions will be held.

Lycoming engine for the new 400-hp. Piper Comanche, the IO-720-A1A, has received Federal Aviation Agency certification. Engine is rated at 400 hp. at 2,650 rpm., weighs 597 lb. and has a compression ratio of 8.7:1. Engine has been approved with 12-v. or 24-v. generators or with a 24-v. alternator and a transistorized voltage regulator.

Mooney Master production has reached a volume of approximately one a day and more than 55 deliveries have been made. Orders for demonstrators have been filled and deliveries to customers have begun, the company said.

Southwest Airmotive golf tournament for business and private pilots will be held May 20 at Brookhaven Country Club, Dallas. Tournament will be held in conjunction with the Aviation/Space Writers Assn. national convention.

Cessna Aircraft Co. led the business aircraft industry in the number of units delivered in 1962 with 3,224 out of a total of 6,601, or 47.4% of the total of the five major manufacturers. This is a net gain of 371 aircraft over 1961.

Pacific Airmotive Corp. has reported 1962 sales of $31,322,160 and net income of $781,599 or $1.07 per share. Income included $347,269 from operations and $434,330 from sale of a division of the company. Sales were up from 1961's total of $27,477,213 and net profit rose from $484,188 in 1961.

Airwork Corp. of Millville, N. J. had sales of $9,597,163 and net income of $363,212 for the six month period ending Jan. 31. Sales and net income for the same period the previous year were $7,695,658 and $200,251 respectively. Per share earnings were 44.6 cents in 1963 and 25.3 cents in 1962.

WHO'S WHERE

(Continued from page 23)

Changes

Woodrow W. Dunlop, director of the Scientific and Technical Information Facility, operated by Documentation, Inc., Bethesda, Md. for the National Aeronautics and Space Administration.

Thomas G. Hart, Jr., assistant controller property manager, United Aircraft Corp., East Hartford, Conn.

Dr. Joseph S. Smith, assistant manager Sperry Gyroscope Co.'s Air Armament Div., Great Neck, N.Y.

Walter R. Nunn has joined the electronic warfare team of the Operations Evaluation Group, Center for Naval Analyses, Arlington, Va.

Joseph Kelley, Jr., has joined Douglas Aircraft Co.'s Washington, D.C., office to coordinate the marketing activity of the Missile & Space Systems Div.

William H. Manning, manager marketing services, Marshall Industries, San Marino, Calif.

K. E. Doriot, manager aerospace products, Union Switch & Signal Div. of Westinghouse Air Brake Co., Pittsburgh, Pa.

Roy E. Rayle, engineering director ordnance systems, Avco Corp.'s Ordnance Div., Richmond, Ind.

William R. Sears, director of marketing, Infrared Industries, Inc., Santa Barbara, Calif.

Dr. James H. Brown, manager, Support Operations Section of General Electric Co.'s Space Sciences Laboratory, Valley Forge, Pa.

J. Robert Esher, manager, Aerospace Ground Equipment Department, Martin Co.'s Electronic Systems and Products Div., Baltimore, Md.

Col. Robert J. Lynch (USAF, ret.), director of command and control systems, General Precision, Inc., Tarrytown, N.Y.

Robert W. Beckwith, manager, Information Systems, Gulton Industries, Inc., Metuchen, N.J.

M. Gene Leas, manufacturing and plant engineer, Mooney Aircraft, Inc., Kerrville, Tex.

Dr. Raymond Pepinsky, physicist and crystallographer of the Pennsylvania State University, has joined the staff of the Armed Services Technical Information Agency (ASTIA), Arlington Hall Station, Va., as a consultant assigned to the ASTIA Technical Research Office.

Bertram A. Kramer, chief engineer, Instrument & Systems Section, Engelhard Industries Inc., East Newark, N.J.

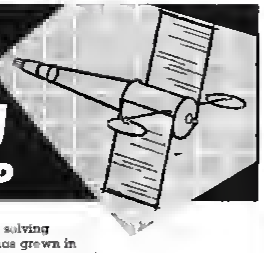
Dr. William J. West, chief engineer, will head the new Advanced Engineering Department in the Armament Control Product Div. of North American Aviation's Autonetics Div., Anaheim, Calif.

Chester J. Dance, military product sales manager, Weston Instruments and Electronics Div., Daystrom, Inc., Newark, N.J.

Horace C. Hearne, Jr., and **Lee G. Weutherbug, Jr.**, operations analysts, have joined the Research Analysis Corp., Bethesda, Md.

O. K. Kowallis, manager research and engineering, United GeoMeasurements Div. of United ElectroDynamics, Inc., Pasadena, Calif.

aerospace engineering ... at AVCO/RAD



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★ Assignments embrace all basic engineering disciplines and their inter relationships on such programs as APOLLO TITAN, MINUTEMAN, NIKE ZEUS and other classified projects.

Openings Exist in the Following Areas:

THERMODYNAMICS
- *Heat Shield Analysis & Design*
- *Temperature Control Systems*
- *Rocket Nozzles*

GUIDANCE & CONTROL
- *Space Flight Mechanics*
- *Astro/Inertial Guidance*
- *Attitude Control Systems*
- *Gas Hydraulic, Electro Mechanical Servos*

MATHEMATICS
- *Applied Analysis*
- *Optimization*
- *Numerical Analysis*
- *Programming*

SPACE FLIGHT-TEST TECHNOLOGY
- *Thermodynamics*
- *Aerodynamics*
- *Systems Evaluation*
- *Trajectory Analysis*
- *Test Range Technology*

AERODYNAMICS
- *Theoretical Aerodynamics*
- *Aerodynamic Design & Development*
- *Experimental Aerodynamics*

GROUND TEST & EVALUATION
- *Space Environmental Engineering*
- *Quality Assurance Engineering*

AEROSPACE VEHICLE DESIGN
- *Re Entry Vehicle*
- *Air/Space Frame Studies Configuration Studies*
- *Structural Design*
- *Test Vehicles*
- *Recovery Vehicles & Systems*
- *Facility Design Engineering*

MATHEMATICAL & ANALYTICAL ANALYSIS
- *Experimental Test Program Design*
- *Test Data Analysis*
- *Statistical Theory of Design*

HUMAN FACTORS
- *Personnel Requirement Determination*
- *Training & Planning*
- *Life Support*
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AVIATION WEEK, APRIL 1, 1963

ANALYTICAL and DESIGN ENGINEERS

Hamilton Standard's planned expansion program has opened a number of new and promising positions on a host of challenging projects.

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LETTERS

McNamara's Band

My name is McNamara,
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We're feared throughout the land.

We play at wakes and funerals,
Our tunes make mourners faint
We almost caused a riot when
We played "The Martyred Saint."

We played for old Macmillan
And we gave him quite a jolt,
We didn't play his favorite,
"The Funding of Skybolt."

Our music grates and irritates,
It makes Scoop Jackson sore
To hear us play that catchy tune,
"No Need for Dyna-Soar."

We gladden hearts of Americans,
Be they of either sex
We'll save this noble country with
The C D TFX

(Name withheld by request)
SEATTLE ENGINEER

Leadership Shortage

In reference to the letter "P D—Quick" by A Scientist in the Mar 4 issue (p 106), I offer the following comments. First, being an engineer, I regard all scientists with suspicion and have even been known to cross the street to avoid meeting one, but at last I must admit that here is a man of exceptional insight. His remarks on the problems that plague our space efforts pinpoint a prime trouble—lack of leadership. There is no shortage of engineers and no scientific manpower deficit. There is a shortage of responsible, authoritative, even dictatorial, leaders. Vacillation, hesitation, study, review and more study are the key words of the day.

Unfortunately (or fortunately, depending on the point of view) I am one of the "recent workers" with only a few years experience and so I do not feel qualified to extend this man's penetrating comments. Let me just state that after a very careful reading and rereading of "P D—Quick" I can think of corresponding examples of creative frustration from my own brief experience on a point to point basis.

I thought the reference to "Alice in Wonderland" was very apt. "When are we going to quit 'playing house' like kids and shoulder responsibilities like men?" As an example of what I consider are kids playing house, I offer an excerpt from an article that appeared in "The Space News Roundup" which is an official NASA-MSC publication. This article discusses at length the temporary, space-age control room communications facility (translation: meeting room).

"The control room, for instance, is a place where an MSC executive can watch launch preparations at Cape Canaveral projected onto a giant 5 x 7 ft screen by commercial TV. . . It is a place where special messages from the President can be seen by a large audience on the same screen. . . ."

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

(Now where did I leave my Capt. Midnight decoder?)

"He [a speaker] can adjust the motorized lectern to his height, control a 'fill light' to eliminate shadows under his chin if he is having his picture taken [horrors, no shadows please—and remember gentlemen, the right profile only], adjust the room light to agree with his visual presentation, control a tape recorder to either record the session or play something back, draw himself a glass of water, and tell instantly how many minutes he's been talking and what time of day it is. . . ."

Now if he just has something to say, we're all set. How did Archimedes and da Vinci get by without a motorized lectern? Just whom are we kidding? Only ourselves. So again I congratulate the succinct scientist with the well turned phrase. Now if he could just find a third person with similar views we could form a committee to discuss this matter further. Let's see, I would be chairman, you would be—

(Name withheld by request)
AN ENGINEER
St. Louis, Mo.

Congratulations to "A Scientist" and to AVIATION WEEK & SPACE TECHNOLOGY for publishing his letter (AW Mar. 4, p. 106).

Let's hope that both military leaders and industrial executives will not only take his words to heart but will also take definite action to clear the path from statement of requirements to delivery of hardware.

In one company we "covered" ourselves with paperwork before we made a move, and moves were made by "move men." Deliveries were very late and costs were high.

Now in another company, a project which has dragged for three years under an overstaffed program office, is now moving ahead under a "czar."

These are examples of what helps to bog down a job, and what can be done to alleviate the mud.

JAMES MASTERSON
Electronics Technician
Natick, Mass.

Mr. "A Scientist" in his letter titled "P D—Quick" in AVIATION WEEK, Mar. 4, 1963, states "quit playing house like kids and shoulder responsibilities like men."

Then this "responsible" man has his name withheld by request.

He couldn't do that in Russia.

Freedom of speech and of the press means you are free to say or print what you like as long as you are willing to take the responsibility for saying it or printing it.

How about it "men"?

R. C. KOLHOFF
Toledo 12, Ohio

Your Mar. 4, 1963, issue in the "letters" page contains a "classic" in P D (preliminary design)—Quick. The author did a magnificent job. The only thing he left out was these same "wheels" stealing ideas, having others work out the details and then have someone write (they might even do some of the correcting themselves) a paper that they can give usually with no acknowledgements. Being a design specialist, first in aircraft then in space work for the past 24 years, I can agree with that knowledgeable author completely.

If I could get a few reprints I would send them around to a few wheels I know at Douglas.

Thank you for printing it, I'm sure this "truth" will "hurt" many—

R. T. KENDALL
Palos Verdes Estates, Calif.

Pilot Unemployment

Even though your magazine does not go into the problems of pilot employment, from the experience I have had in the last nine months, there is indeed a problem. Having flown for the last nine years, seven of them in 200 000 lb plus aircraft, I was under the misconception that there would be a position for a commercial multi-engine jet pilot with 1,875 hr. After contacting the commercial airlines and business corporations that use aircraft, I find that there is no need for an old pilot of 28 who has flown under all weather conditions. So it's into a new career field after leaving many years of what I thought was needed and expensive to find a position that doesn't have the bottom drop out.

JOSEPH J. HAAS
Riverside, Calif.

Flights to Planets

In your Mar. 4 issue (p. 56) you describe the studies being conducted at Lockheed Missiles & Space Co. on manned interplanetary flight in the article, "Manned Venus-Mars Fly-by in 1970 Studied." This article summarizes some of the efforts in trajectories, re-entry techniques, guidance, and life support and protection. Unfortunately, you state that the study did not examine problems associated with prolonged weightlessness, confinement in a small space, and psychological effects of stress and distance travel from the home planet.

Although this portion of our program was not reported at the IAS meetings in New York, we have conducted considerable analyses in the areas of capsule layout, pseudo-gravitation, crew size, isolation and confinement, task analysis, work-rest cycles, selection training, and other factors related to crew performance during a long term interplanetary mission.

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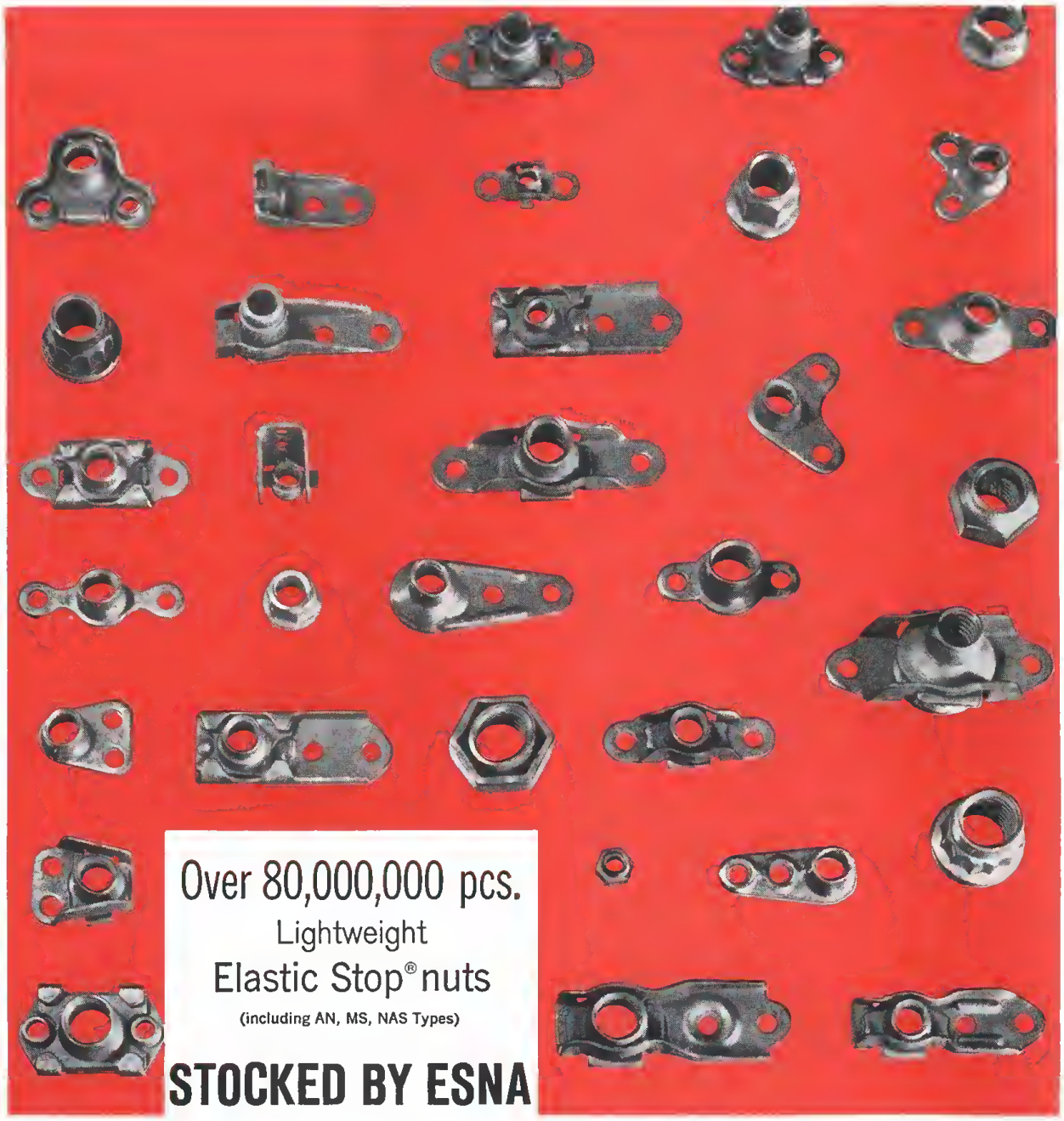

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